Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

JUNE, 1950

TECHNOLOGY DEPT.
TABLE OF CONTENTS, Page 51

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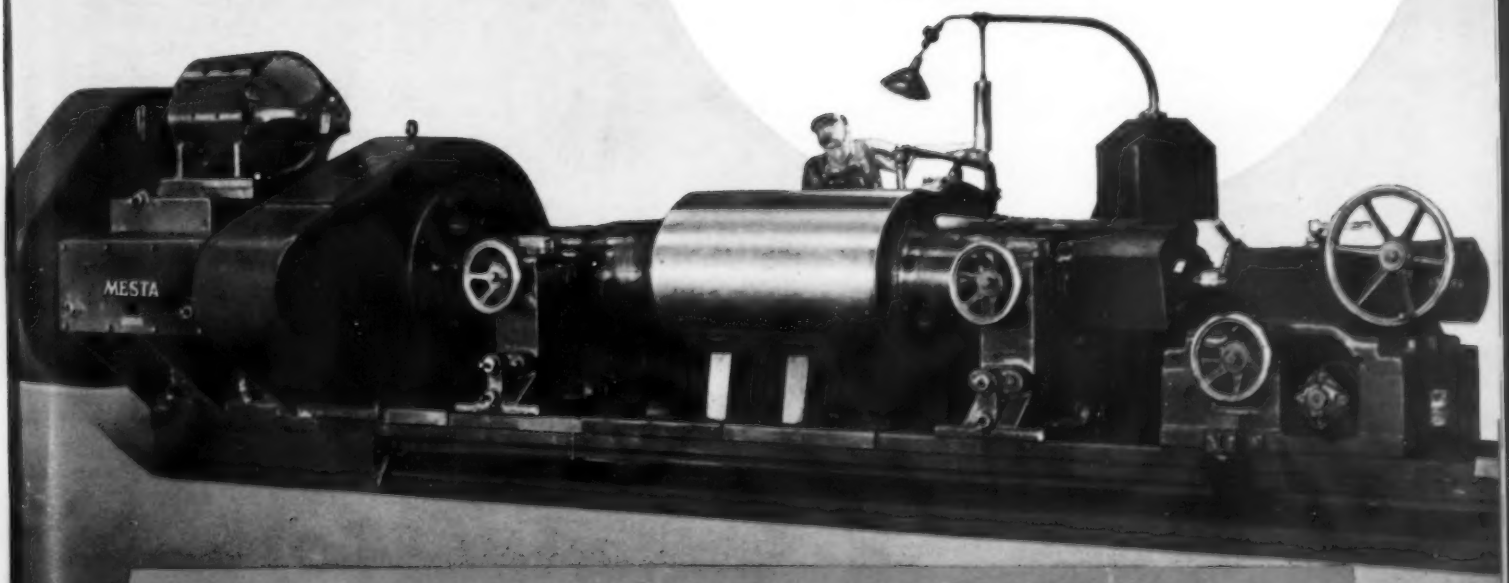
JUN 23 1950
DETROIT

MESTA
Heavy Duty
Roll Grinders

Mesta Roll Grinders of simplified design are the most accurate and dependable grinding machines available. Built with precision for finest finishing and ruggedness for heaviest roughing.

Finishing a 36½" x 56" Mesta Alloy Iron Roll in a Mesta 60" Heavy Duty Roll Grinder.



Designers and Builders of Complete Steel Plants

MESTA MACHINE CO. PITTSBURGH, PA.

what are the FACTS ABOUT SAFETY SWITCHES?

1 IS "INTERNAL HEATING" IN SAFETY SWITCHES IMPORTANT?

Engineering research fully authenticated by outstanding authorities shows "internal heating" in Safety Switches to be the principal cause of Safety Switch failures.

2 HOW DOES "INTERNAL HEATING" CAUSE SAFETY SWITCH FAILURES?

By literally baking the life out of Safety Switch parts. It causes insulating materials to disintegrate, metal parts to warp and corrode, so switches either become inoperative or "burn up" through inability to carry the load.

3 WHAT CAUSES "INTERNAL HEATING" IN SAFETY SWITCHES?

In properly constructed Safety Switches, fuses are responsible almost exclusively for "internal heating." This is no criticism of fuses; it is unavoidable. Any fuse carrying its rated load *must* be near its melting point if it is to perform properly when an overload occurs. Any metal operating *near* its melting point must be *hot* and fuse links *are* hot, with temperatures running as high as 700 degrees Fahrenheit.

4 HOW CAN THE TROUBLE FROM "INTERNAL HEATING" BE OVERCOME?

As the adequate enclosure so fundamental to *safety* in Safety Switches makes thorough venting of the trapped heated air impossible, the only escape from the ravages of "internal heating" can come through selecting materials for the internal structure and designing this structure to successfully withstand the unavoidable heat conditions to be met in service.

CUTLER-HAMMER
SAFETY SWITCHES
C-H

5 WHAT SAFETY SWITCHES AVOID "INTERNAL HEATING" TROUBLES?

Cutler-Hammer Safety Switches. Cutler-Hammer Safety Switches were completely redesigned *ten years* ago to beat "internal heating" when engineering research clearly indicated the need for *such* Safety Switches. Nine years of experience shows the Cutler-Hammer claim of better Safety Switch performance far more than a mere promise; it is a proven *fact*. Ask the men who use them. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wis.

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania,

Pay-Off Reels

Aetna Pay-Off Reel with screw operated lift, chain traverse and mechanical drag. Aetna reels furnished with or without unloading facilities.

Aetna Pay-Off Reel with coil carriage and coil centering device, showing collapsed mandrel. The four quadrants give full support to the coil, eliminating coil breaks.

Aetna Pay-Off Reel with expanded mandrel. This view also shows coil carriage and coil centering device.

- Furnished with or without loading facilities.
- Four quadrants give full support to coil, eliminating coil breaks.
- Hydraulic or mechanical lift and traverse.
- Manual or automatic side register control.
- Regenerative or hand braking for back tension.
- Air or hydraulic head expansion.
- A patented feature centers coil automatically.

any size ... any combination

THE AETNA-STANDARD ENGINEERING COMPANY

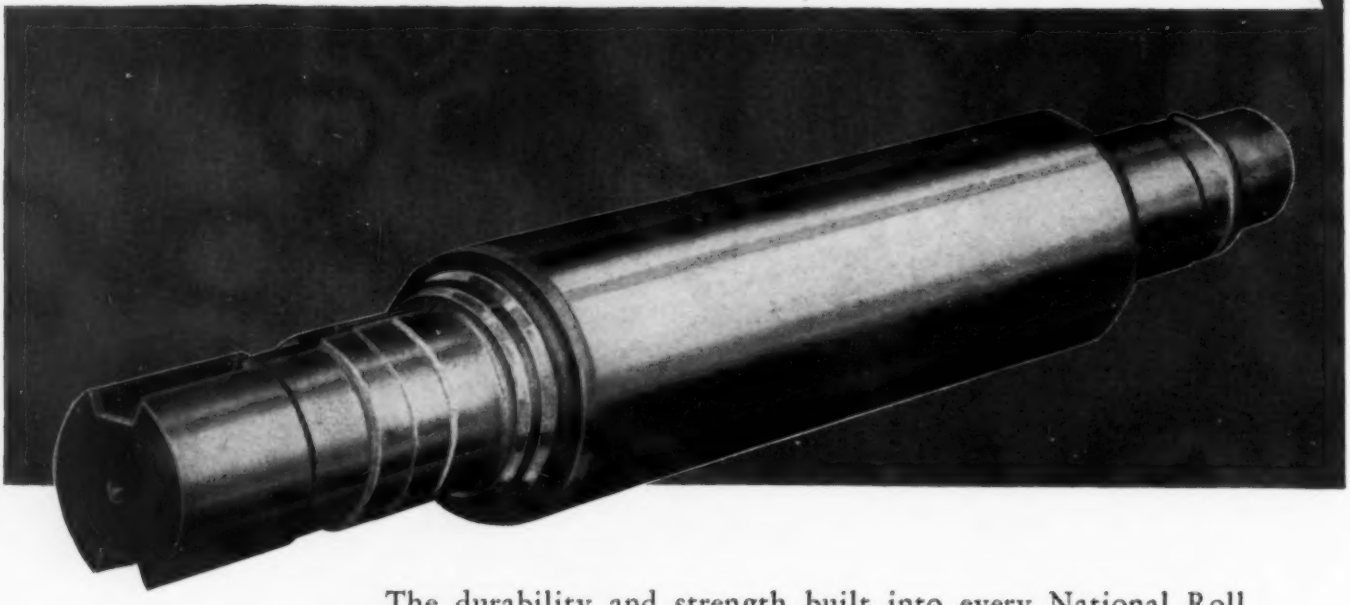
YOUNGSTOWN, OHIO

ASSOCIATED COMPANIES

AETNA-STANDARD ENGINEERING CO., LTD., TORONTO, ONTARIO, CANADA
HEAD, WRIGHTSON & COMPANY, LTD., THORNABY-ON-TEES, ENGLAND
SOCIETE DE CONSTRUCTIONS DE MONTBARD, 8 RUE DARU, PARIS (8e) FRANCE

KEEP DOWNTIME DOWN AND PRODUCTION UP!

Specify National Rolls



The durability and strength built into every National Roll means greater tonnage life on your stands and fewer shut-downs for roll changes. Their dependability has been proven by their use in mills throughout the country for more than forty years.

Whether your requirements call for iron or alloy iron rolls in rough necked, roughed turned or finished form, National can supply them to meet your exact requirements. Specify National Rolls and see.

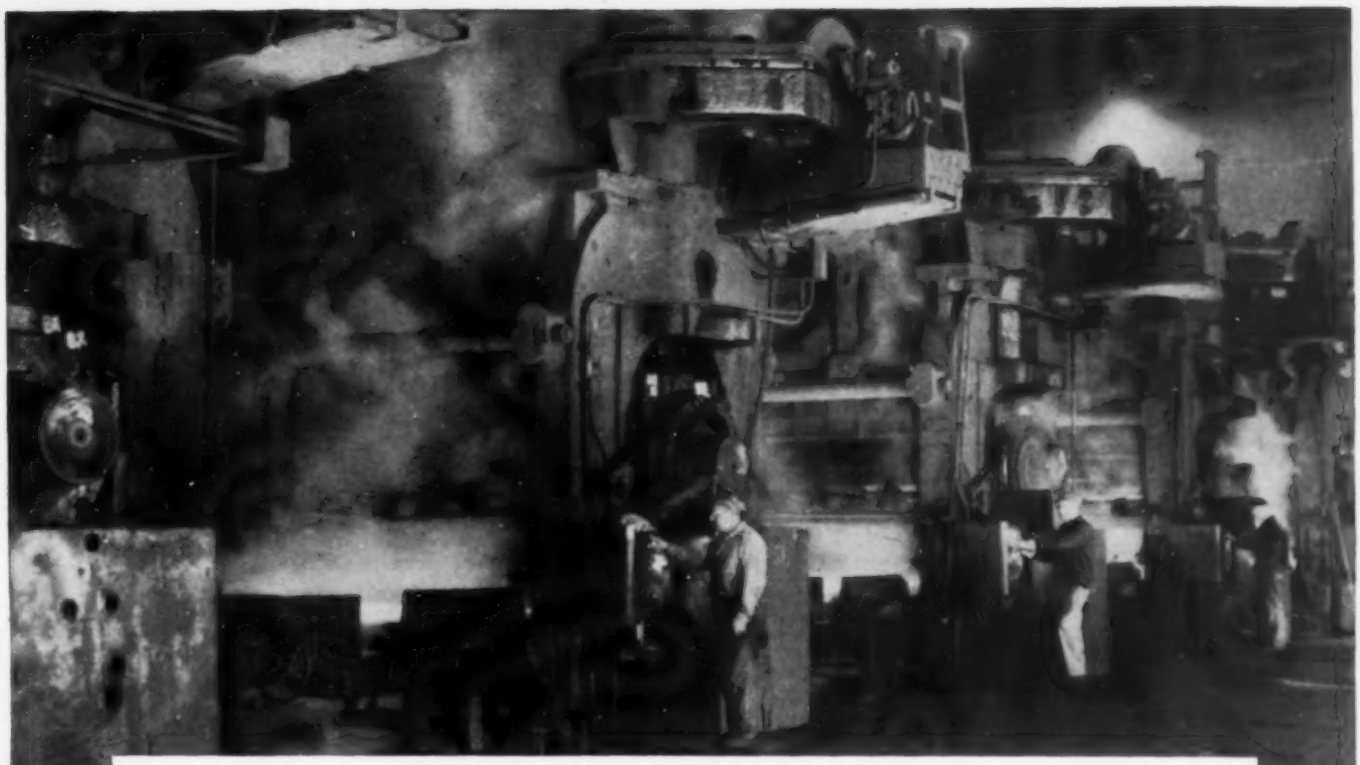
NATIONAL ROLLS

THE NATIONAL ROLL & FOUNDRY CO.

Avonmore, Pennsylvania

Specialists in

Iron and Alloy Iron Rolls and Castings



PROTECT BACK-UP ROLL NECKS

...with the oil that keeps lines and bearings clean— TEXACO REGAL OIL

Your back-up roll necks roll on a film of oil. When you use *Texaco Regal Oil* the film is tough enough to carry the heaviest loads, and it's *always there*. That's because *Texaco Regal Oil* keeps the oil lines clean, bearings flooded with lubricant.

Texaco Regal Oils are turbine-quality lubricants especially designed to resist oxidation, emulsification and sludging. They stand up under operating temperatures . . . assure smooth, trouble-free performance . . . longer bearing life . . . lower maintenance costs.

The best protection for the reduction gears on the drive side of your roll stands, is *Texaco Meropa Lubricants*. These are "extreme pressure" lubricants with exceptional resistance to oxidation, thickening and foaming. Use them to prolong the life of both gears and bearings.

Throughout your mill, Texaco Lubricants can improve performance and reduce costs materially. Let a Texaco Lubrication Engineer give you full details. Just call the nearest of the more than 2,000 Texaco Wholesale Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Regal Oils

(HEAVY CIRCULATING OILS)

BONNOT INSPECTION TABLE

PROVEN KEY TO

Greater Steel Production AT LOWER COST PER TON

Whether you have *billets or bars—rods or rails—small slabs or tubes* for inspection in your mill, a Bonnot Inspection Table will give you greater production . . . at lower cost per ton.

Used for any general inspection, or in conjunction with the Bonnot Billeteer, the Hydraulic Inspection Table is another pioneering development (proven in service) of Bonnot engineers that offers these major advantages:

EASY! Inspection and marking flaws in billet—one side; with Bonnot Hydraulic Inspection Table, operator works easily, efficiently, safely.

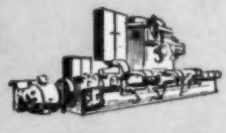
FAST! Inspection and marking flaws—2 sides and corner at the same time, and within reach of operator without his changing position.

ECONOMICAL! Discharging billet forward after marking. Note unmarked billet (at lower right) awaiting placement for "practically continuous" inspection.

1. assures faster, better inspection because inspector sees 2 faces at one time; he completes all operations from just one position, and with easy wrist motion.
2. enables inspector to work without interfering with Billeteer operator or other billet-cleaning workers and vice versa.
3. increases production because one Inspection Table can keep as many as 6 Billeteers operating at capacity.
4. segregates sizes of raw material so it can be "worked" in practical sequence; production up 15% or more.
5. available for other inspection work involving the quick, accurate and effective handling of heavy material.
6. saves machine time because inspection and marking are done in advance.
7. eliminates need of putting all material through machine; normal practice when pre-machine inspection is not provided.
8. eliminates dangerous, time-consuming hard work of floor inspection.
9. reduces accident hazards, frees storage space for other uses because material is handled more efficiently.
10. speeds "conditioning" by "sorting" material according to work—(a) surfaced completely, (b) flaws or spotting, (c) rejects, (d) no machining.

BONNOT WILL "ENGINEER" AN INSPECTION TABLE TO YOUR EXACT NEEDS. WRITE TODA

The Bonnot STEEL EQUIPMENT DIVISION CANTON 2, OHIO Co.



THE BILLETE

ALSO MANUFACTURERS OF

Alliance

FIRST IN SIZE
FIRST IN CRANE DESIGN

INDUSTRY WANTS SAFETY, YOU GET SAFETY WITH ALLIANCE CRANES

● Dependably safe! That's this 4-girder Alliance Ladle Crane. With a wide safety factor, it's engineered to operate 24 hours daily year after year with unbelievable minimum of maintenance. This powerful crane is equipped with an auxiliary trolley having a 60-ton and 20-ton hoist, safety rope reeving and synchronized worm drive, and a safety compartment containing a duplicate bridge master control. This lets the operator move the crane in safety in case hot metal is accidentally spilled. Another Alliance safety feature is the enclosed stairway leading from the cab to footwalk on the crane girder.

Known the world over, Alliance Cranes handle more hot metal than any other make. Alliance has constructed the largest cranes ever built considering height and capacity of lift.

Think now about giving your plant more lifting power by developing new cranes or reconverting old ones.

BIG CRANES

THE ALLIANCE MACHINE COMPANY

MAIN OFFICE
ALLIANCE, OHIO

PITTSBURGH OFFICE
1622 OLIVER BUILDING, PITTSBURGH, PA.

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY

Loading up...FOR A 40% SAVING

CUT UP TO $200,000 A YEAR FROM REFUSE DISPOSAL COSTS

From Open Hearth to Dump and back again. That can be a costly operation or just a normal operating expense.

It all depends on the equipment used.

Gondola, hopper or obsolete air dump cars run the cost of refuse disposal way up out of sight. They're not built for the job. The heat of lading and banging of buckets makes maintenance and repair quite a sizeable item on your annual budget. On top of that, there's added labor costs, loss of operating time and haulage waste due to inefficient equipment.

Here's how you can bring those costs down within reach and maintain an even higher degree of operating efficiency – New Magor Air Dump Cars – built specifically for steel plant service.

New Magor Air Dump Cars are a modern low-cost approach to refuse disposal. They can take the roughest treatment year in and year out with a minimum of maintenance expense. Through labor and maintenance savings alone, you can write off your entire investment within a few years.

COST LESS THAN $1.35 A DAY

That's all it costs to own a 30 yd. 70 ton Heavy Duty Steel Plant Magor Air Dump Car – *dump cars that can cut your refuse disposal costs as much as 40%.*

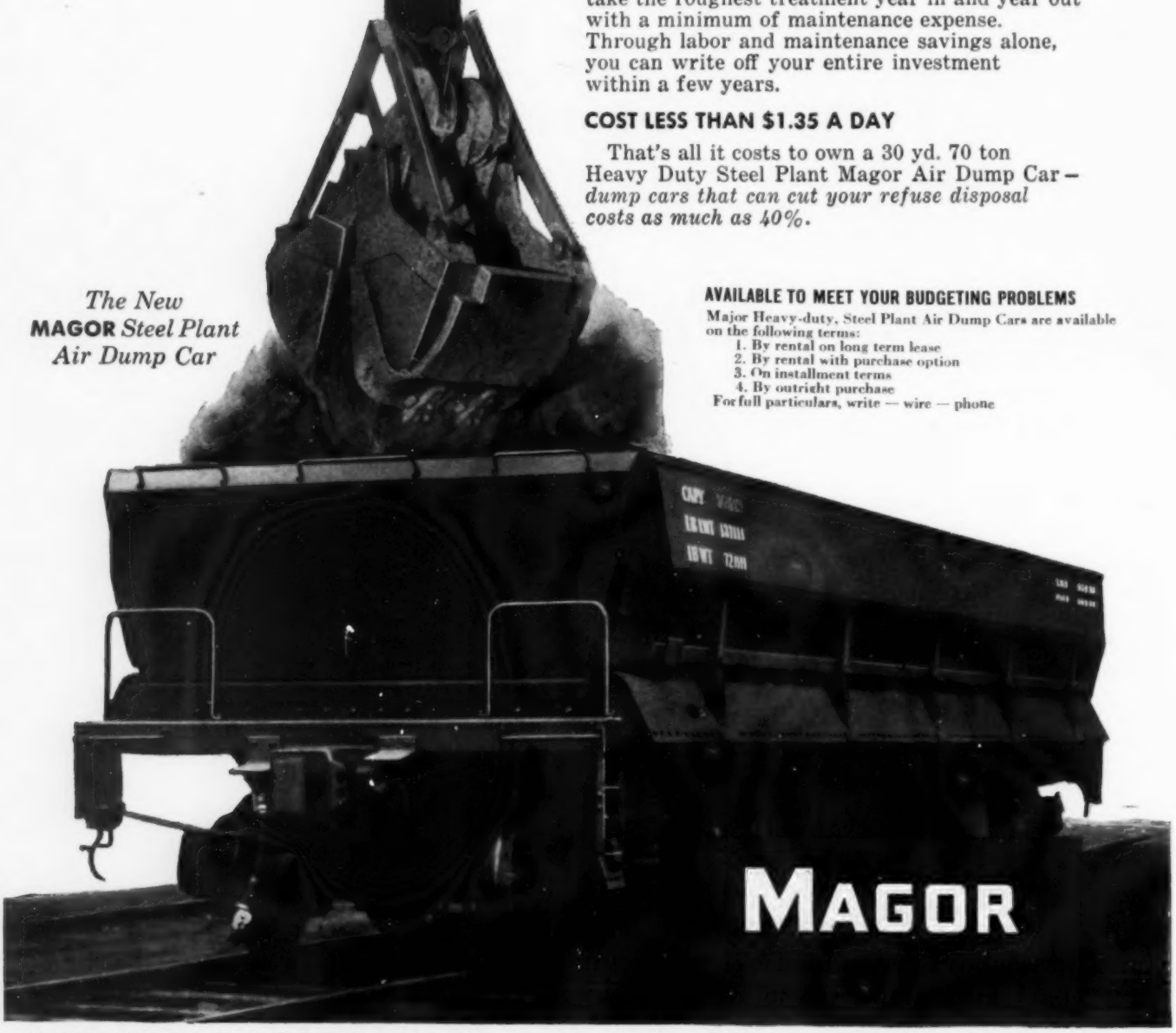
The New **MAGOR** *Steel Plant Air Dump Car*

AVAILABLE TO MEET YOUR BUDGETING PROBLEMS

Major Heavy-duty, Steel Plant Air Dump Cars are available on the following terms:

1. By rental on long term lease
2. By rental with purchase option
3. On installment terms
4. By outright purchase

For full particulars, write — wire — phone



MAGOR CAR CORPORATION · 50 CHURCH ST., NEW YORK 7, N. Y.

Now—One grease will service all grease applications in the majority of plants

Gives ALL THESE PLANT SAVINGS:

1. **Extends TIME between greasings**—lasts longer . . . stays in bearings longer.
2. **Low-cost application**—fewer servicings and *only the one grease* to handle.
3. **Simple inventory**—Shell Alvania Grease replaces up to 20 brands formerly required.
4. **Better protection**—against heat, cold and moisture.
5. **Greater safety**—less chance of applying the wrong grease!

Gives ALL THESE LUBRICATION ADVANTAGES:

1. **Higher mechanical stability** than any conventional grease at operating temperatures.
2. **Pumpable at low temperatures**—even in unheated storage.
3. **Stable at high temperatures**—superior to the best "soda" greases.
4. **Impervious to water**—excellent resistance to washing out.
5. **Longer service life**—reduced consumption.

The "MILLION-STROKE" Industrial Grease!

A grease that will stand 100,000 punishing strokes of the ASTM Work Tester has been considered a superior lubricant.

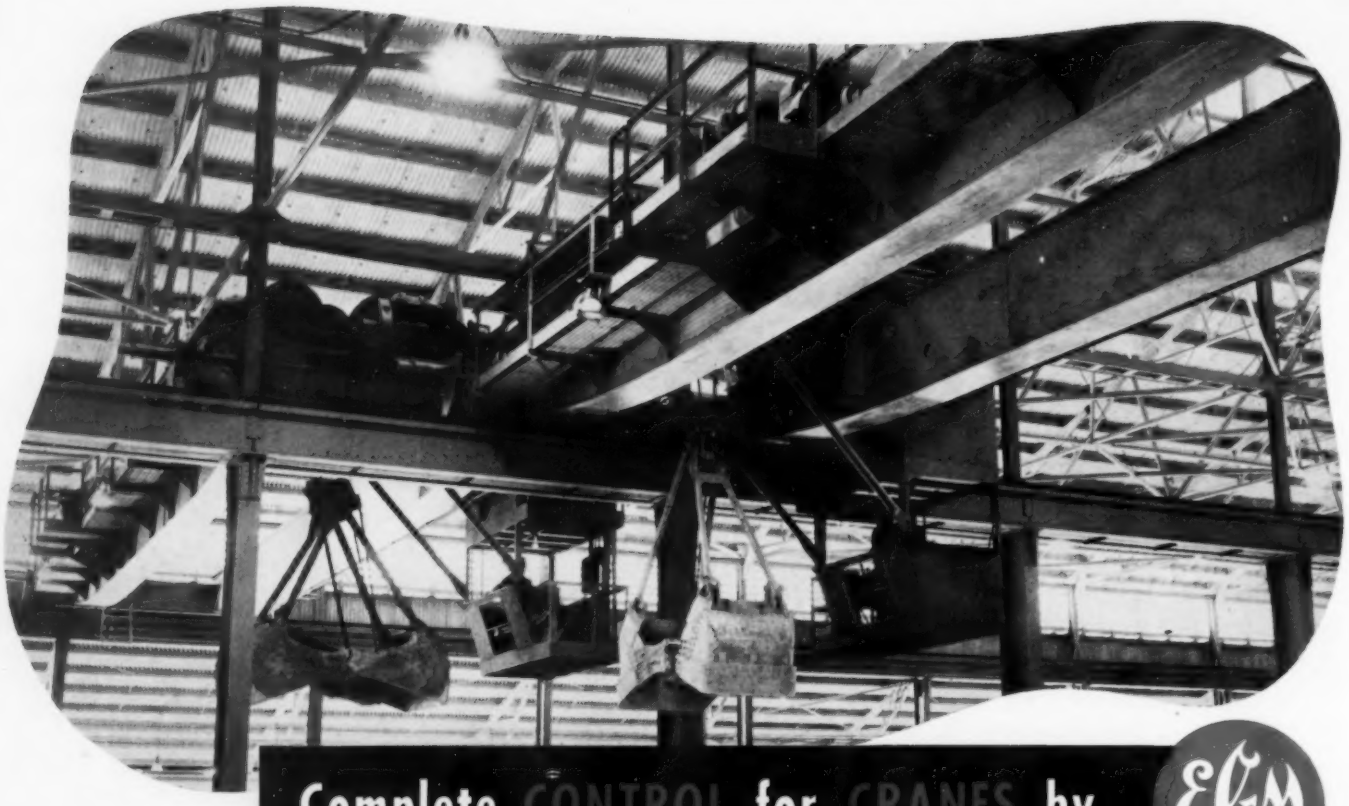
In a deliberate attempt to break down Shell Alvania Grease, *on the same tester* the run was extended...200,000 strokes...300,000 strokes . . . 500,000 strokes! Finally, at one million strokes the test was discontinued, because this grease *would not break down*—it was still a fit lubricant both in appearance and consistency.

SHELL OIL COMPANY

50 West 50 Street, New York 20, N. Y. • 100 Bush Street, San Francisco 6, California

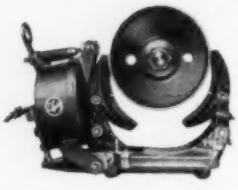
SHELL®

SHELL ALVANIA . . . The "MILLION STROKE" Grease

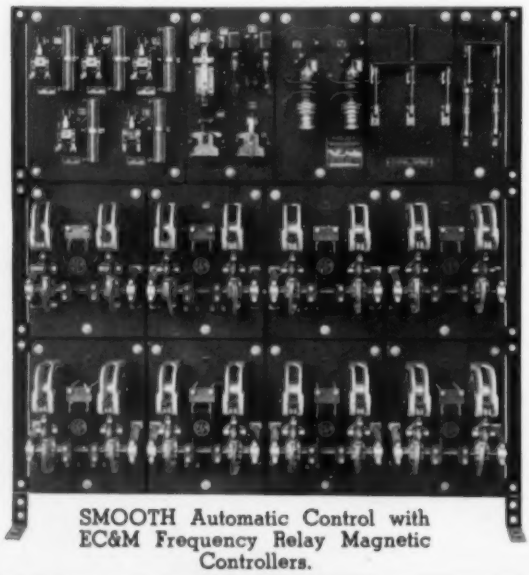


Complete CONTROL for CRANES by EC&M

SHORT-THROW Narrow-width Cam Master Switches are easy on the operator.



LONG - LIFE Brakes give high-speed performance — with low up-keep.



SMOOTH Automatic Control with EC&M Frequency Relay Magnetic Controllers.

Users Know EC&M Equipment Gives Top Performance . . . Low Up-Keep

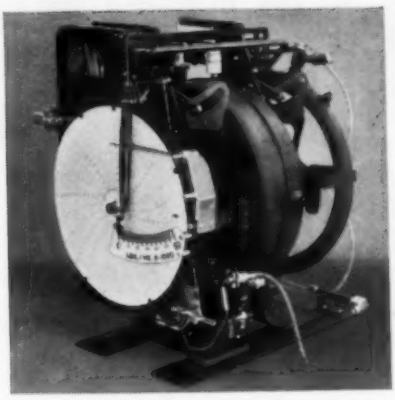
EC&M Crane Apparatus and Control Engineering have a reputation for eliminating initial delays and for permitting production to be maintained at a high level throughout the life of the investment.

EC&M Crane Equipment is specially engineered for *each* crane. EC&M has *always* built control from the crane data sheet. Relay-settings, resistor-fillings, brake-windings, etc., are matched to the actual crane-loading. Result is top performance right from the start.

Many crane users, when buying new cranes or revamping existing installations, specify EC&M Control. They know the extra margin of safety built into EC&M Equipment and the accurate engineering of the apparatus result in freedom from delays—smooth performance. Write EC&M into the specifications for your next crane.

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79th STREET • CLEVELAND 4, OHIO

When Buying Cranes... Specify EC&M CONTROL

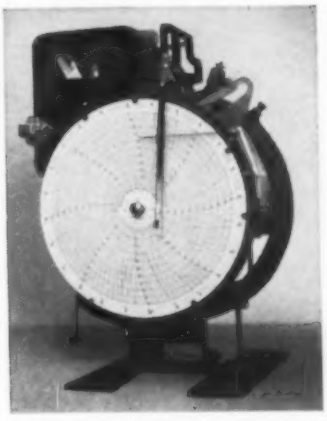


Dual meter with high pressure ring using mercury for sealing fluid. Oil is used in low pressure ring.

Mercury level is not critical, in

HAGAN

RING BALANCE METERS



Single ring, high differential meter, with integrator.

Meter case for single ring meter. Case for dual meter occupies same panel space but is 5 inches deeper.

In conventional meters, mercury level must be exactly right to start with, and any loss of mercury throws the meter out of calibration.

Mercury level, however, is one of the many things you don't have to worry about in Hagan Ring Balance Flow Meters. The sole function of the mercury is to serve as a seal, and the only care necessary is to keep the level high enough for that purpose.

This and other features make maintenance extremely simple—and ease of maintenance is only one of the advantages of these meters. For full information on these meters, or on any application in which you are interested, write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pennsylvania.

HAGAN
HALL
BUROMIN
CALGON

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

"no more GAMBLING on tool steel selection"

[⅓ actual size; Selector is in 3 colors]

Since the first announcement, hundreds of tool steel users have received their CRUCIBLE TOOL STEEL SELECTORS. The comments received indicate that this handy method of *picking the right tool steel right from the start* is going over big.

"Handiest selector I've ever seen"

"No more gambling on tool steel selection"

"You're right, the application should dictate the choice of the tool steel" . . . and many, many more favorable comments.

You'll want your CRUCIBLE TOOL STEEL SELECTOR. It uses the only logical method of tool steel selection—begin with the application to pick the right steel! And the answer you get with one turn of the Selector dial will prove satisfactory in every case, for the CRUCIBLE TOOL STEEL SELECTOR covers 22 tool steels which fit 98% of all Tool Steel applications. ALL the tool steels on the Selector are in Warehouse Stock . . . that means when you get the answer, you can get the steel . . . fast!

Write for your Selector today! We want you to have it, because we know you've never seen anything that approaches your tool steel problems so simply and logically. Just fill out the coupon and mail. Act now! CRUCIBLE STEEL COMPANY OF AMERICA, Chrysler Building, New York 17, N. Y.

Here's how it works:

To use the Selector, all you need know is the characteristics that come with the job: type and condition of material to be worked, the number of pieces to be produced, the method of working, and the condition of the equipment to be used.

FOUR STEPS—and you've got the right answer!

1. Move arrow to major class covering application
2. Select sub-group which best fits application
3. Note major tool characteristics (under arrow) and other characteristics in cut-outs for each grade in sub-group
4. Select tool steel indicated

That's all there is to it!

Here's an example:

Application—Deep drawing die for steel

Major Class—Metal Forming—Cold

Sub-Group—Special Purpose

Tool Characteristics—Wear Resistance

Tool Steel—Airdi 150

One turn of the dial does it!

And you're sure you're right!!

Crucible Steel Company of America
Dept. IS, Chrysler Building
New York 17, N. Y.

Gentlemen:

Sure! I want my CRUCIBLE TOOL STEEL SELECTOR!

Name_____ Title_____

Company_____

Street_____

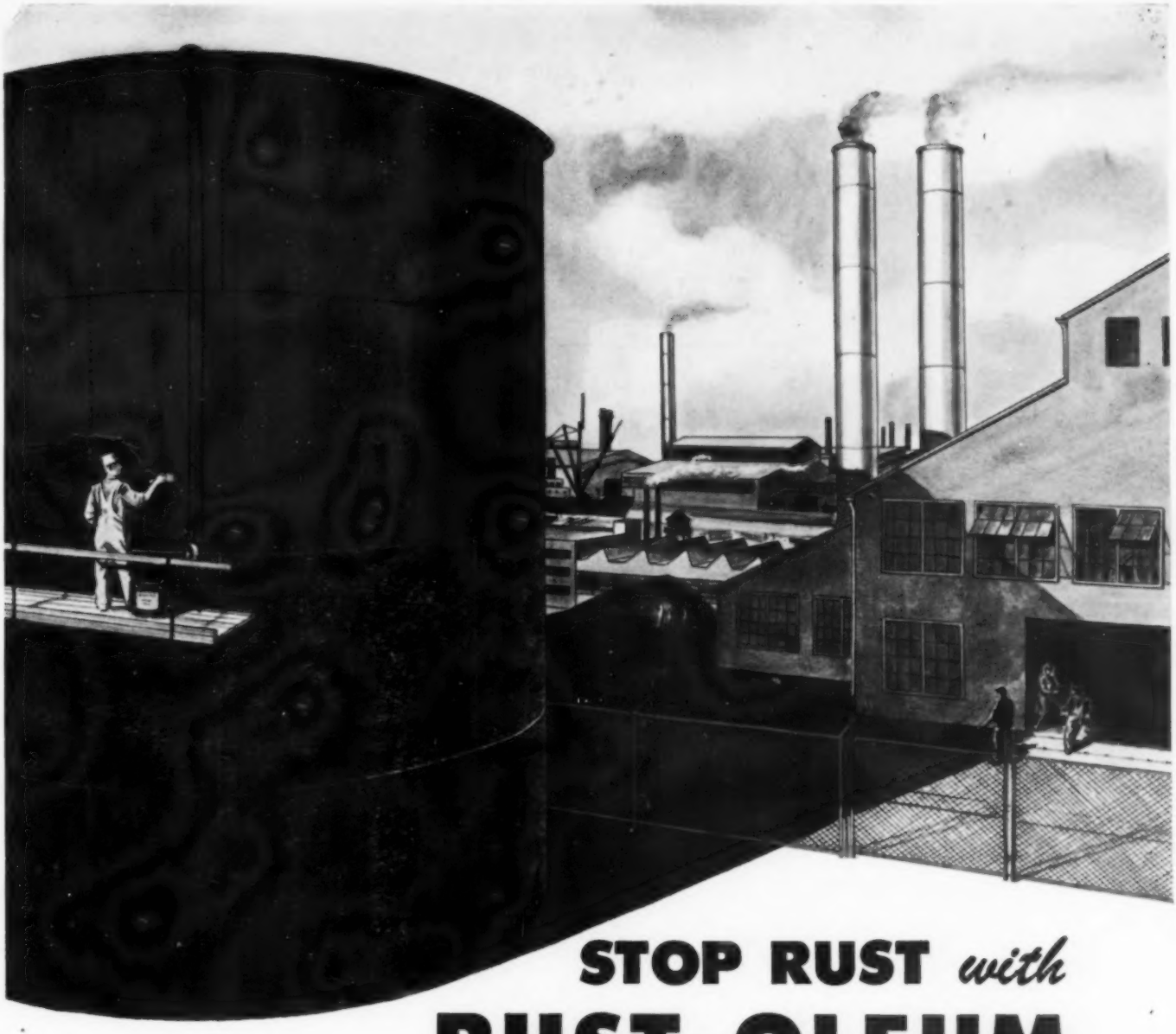
City_____ State_____

CRUCIBLE first name in special purpose steels

TOOL STEELS

fifty years of Fine steelmaking

Branch Offices and Warehouses: ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHARLOTTE • CHICAGO • CINCINNATI • CLEVELAND • DENVER • DETROIT HOUSTON, TEXAS • INDIANAPOLIS • LOS ANGELES • MILWAUKEE • NEWARK • NEW HAVEN • NEW YORK • PHILADELPHIA • PITTSBURGH • PROVIDENCE ROCKFORD • SAN FRANCISCO • SEATTLE • SPRINGFIELD, MASS. • ST. LOUIS • SYRACUSE • TORONTO, ONT. • WASHINGTON, D. C.



STOP RUST *with* RUST-OLEUM

If you have a rust problem, and would like a free survey and recommendations, send your name and address on your business stationery. A qualified factory representative will arrange this free service, which includes a trial size of Rust-Oleum for specific test purposes. There is no obligation on your part. Write today.

Every day rust eats away at your metal tanks, buildings, fences, stacks . . . everything metal inside and outside your plant. Yet, rust and costly rust depreciation can be *stopped instantly . . . economically* . . . with RUST-OLEUM.

Industry of all kinds . . . railroads, steamship lines, iron and steel companies, refineries, in fume-choked industrial and coastal areas have proved Rust-Oleum for more than 25 years. They know that Rust-Oleum stops and prevents rust!*

Rust-Oleum can be applied without extensive preparation . . . even over surfaces that are already rusted. Rust-Oleum spreads evenly . . . free of brush marks. Its tough, pliable finish protects against every kind of weather, against fumes and heat . . . even against salt air and salt spray.

Beauty and durability are combined in Rust-Oleum for it is available in a large selection of colors . . . including aluminum and white.

Don't wait another day! Let Rust-Oleum give you safe, sure, economical protection against rust. Use it to protect all your metal surfaces. Specify it to your painting contractor or architect. Industrial distributors in all principal cities of the United States and Canada stock Rust-Oleum to supply your every need. See Sweets for complete catalog and nearest source of supply, or write us direct.

* *Names on request.*

RUST-OLEUM CORPORATION

2442 Oakton Street, Evanston, Illinois

Continental

PRODUCERS OF: ***Complete Rolling Mill Installations including:***

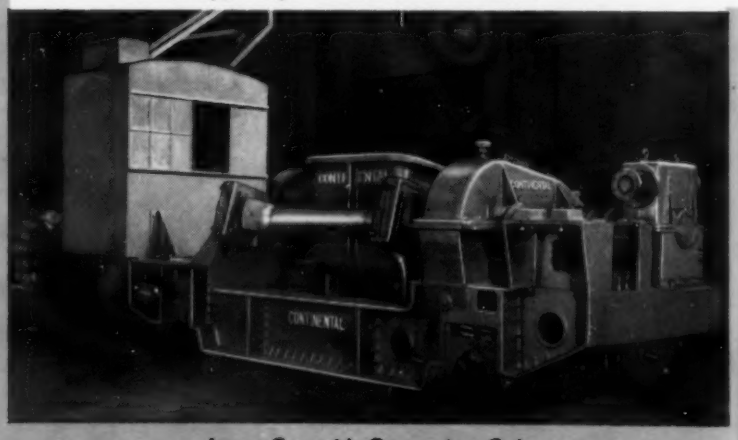
BLOOMING MILLS
STRUCTURAL MILLS
BAR MILLS
BILLET MILLS
MERCHANT MILLS
PLATE MILLS
SLABBING MILLS
UNIVERSAL MILLS
HOT STRIP MILLS
COLD STRIP MILLS
NON-FERROUS MILLS
ROLL LATHES
INGOT MOLD CARS
CHARGING BOX CARS
DE-PILERS
TABLES
TRANSFERS
SHEARS and other auxiliary steel plant equipment

IRON, ALLOY IRON and STEEL ROLLS for ferrous and non-ferrous rolling mills; pulp and paper industry; textile industry; and milling, cereal and vegetable oil industries.

CARBON and ALLOY STEEL CASTINGS from 20 to 250,000 pounds. Complete heat treating and machining facilities.

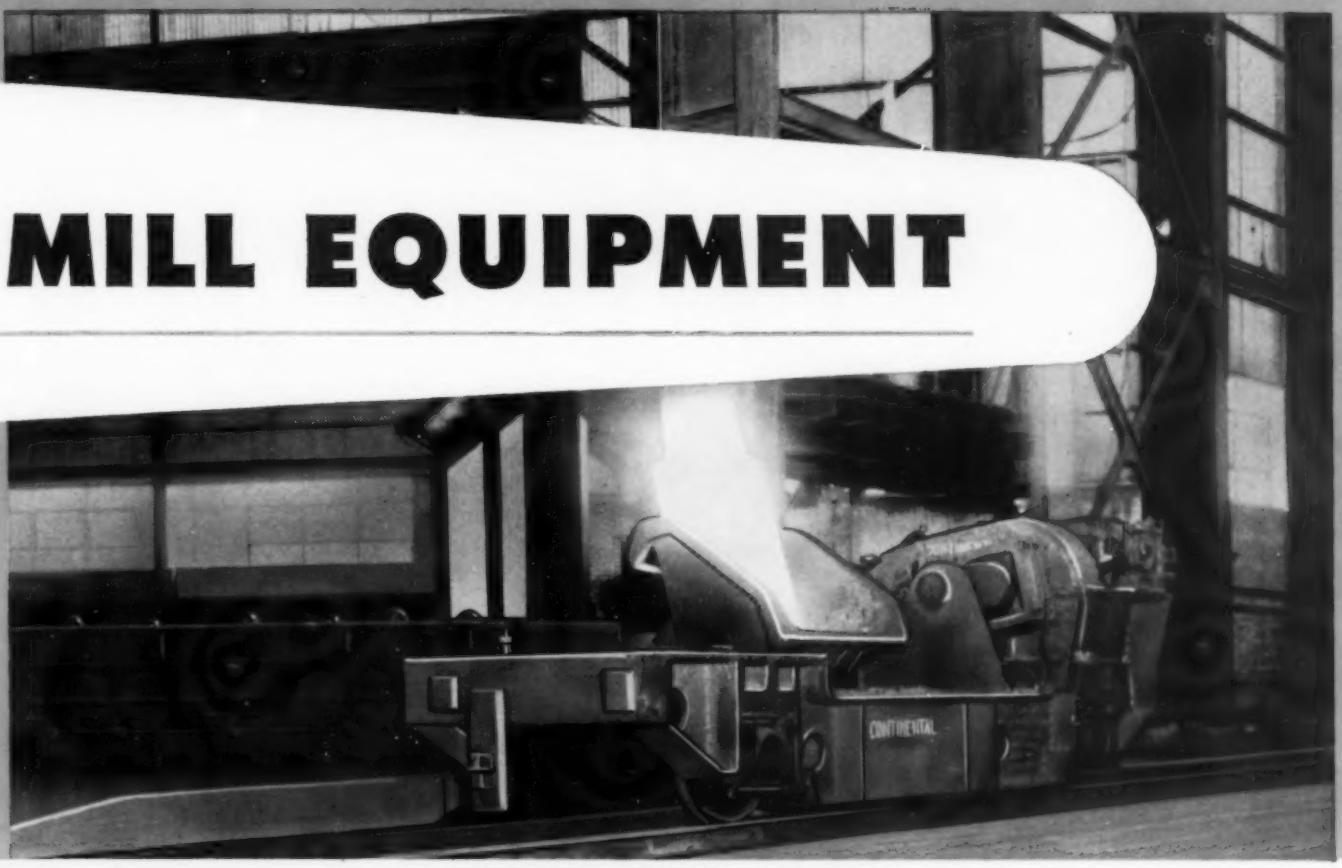
End Tilt Ingot Car

Roller Type Ingot Car and Retractable Table

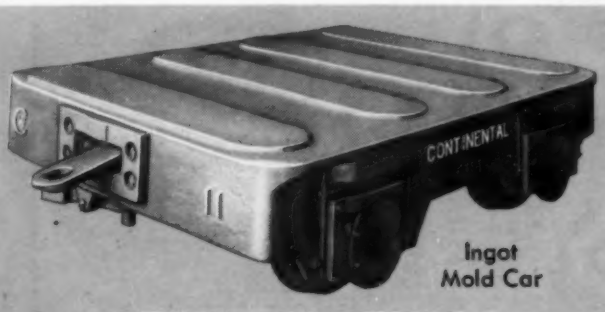


Ingot Car with Operating Cab

MILL EQUIPMENT



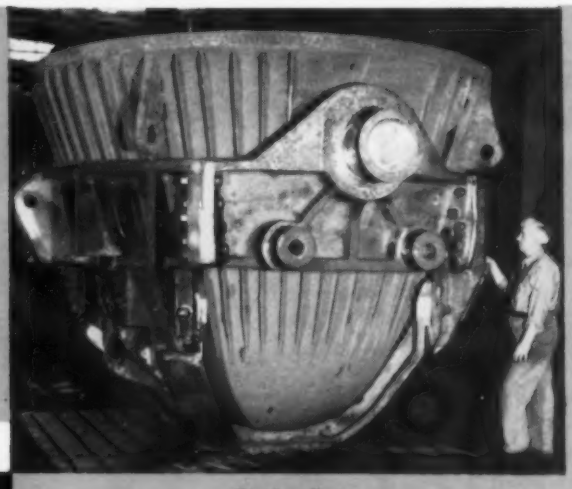
Side Tilt Ingot Car—Remote Control



Ingot
Mold Car

STEEL CASTINGS

20 TO 250,000 POUNDS



Cinder Pot

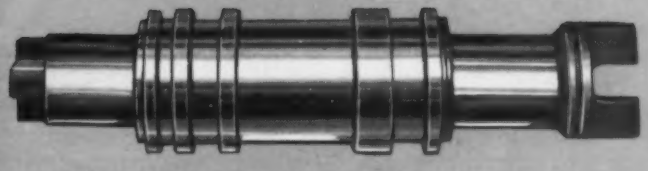
Continental

Continental

FOUNDRY & MACHINE CO.

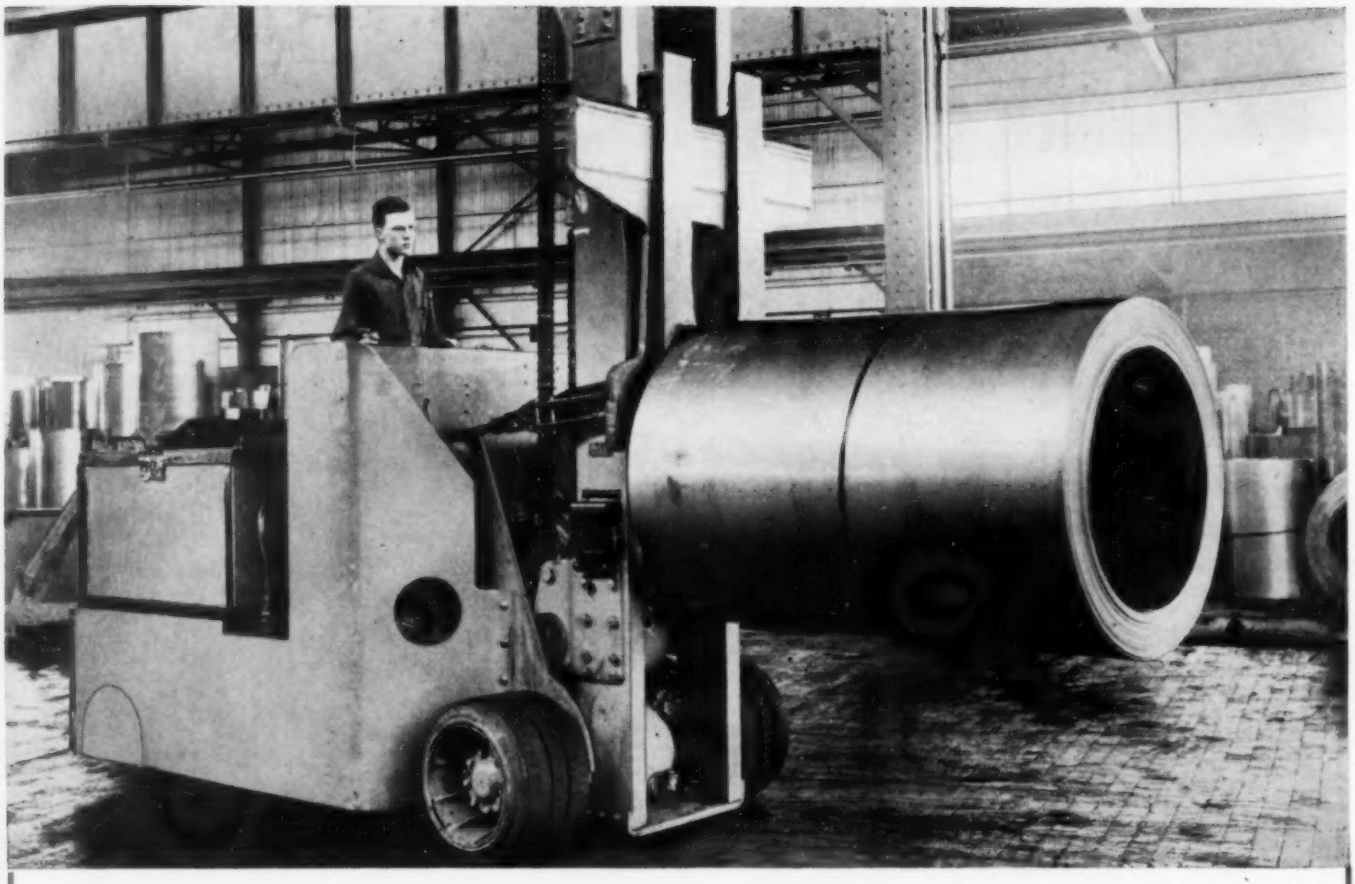
CHICAGO · PITTSBURGH

Plants at East Chicago, Ind. • Wheeling, W.Va. • Pittsburgh, Pa.



ROLLS

IRON, ALLOY IRON AND STEEL



You get FULL SHIFT trucking operations with

EXIDE-IRONCLAD BATTERY POWER

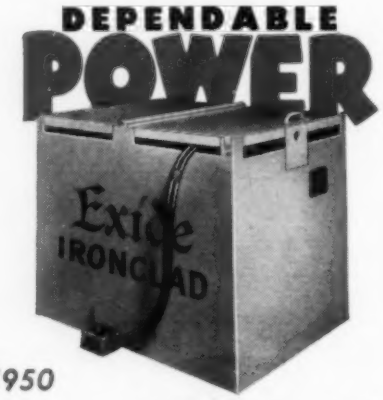
You can count on uniform performance throughout each shift when your battery electric trucks are powered by Exide-Ironclads. Your trucks will handle as much load during the last hour as during the first . . . with practically no difference in speed . . . with no unscheduled periods of down time.

Exide-Ironclad Batteries deliver power instantly to meet all demands—light or heavy—in *start-stop, lift-and-shift* manipulations. They assure you finger-tip control, accurate spotting, easy maneuvering, safe handling. You also benefit from the savings that Exide-Ironclad Batteries provide—low operating costs, low maintenance costs, an exceptionally long life . . . proved in more than 100,000 heavy-duty jobs.

The combination of these superior characteristics make Exide-Ironclad Batteries your best power buy . . . *at any price.*

Write for more facts and FREE copy of Exide-Ironclad Topics. It contains latest developments in materials handling . . . shows actual case histories.

THE ELECTRIC STORAGE BATTERY COMPANY
Philadelphia 32
Exide Batteries of Canada, Limited, Toronto



1888...DEPENDABLE BATTERIES FOR 62 YEARS...1950

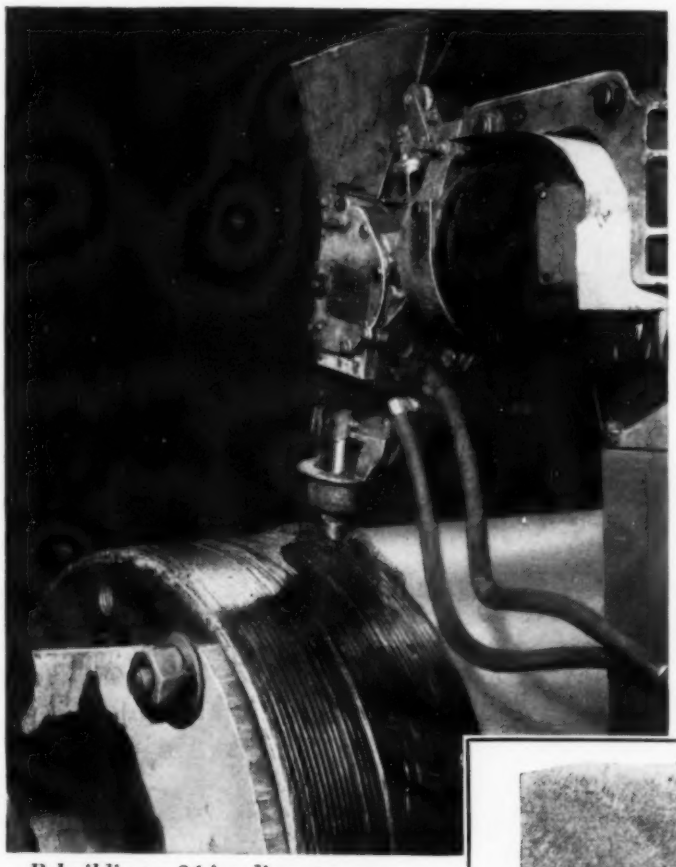
"Exide-Ironclad" *Reg. Trade-mark U. S. Pat. Off.*

Give New Life to Worn Parts

. . . *Rebuild Them by UNIONMELT Welding*

This automatic process saves time and money—welding is fast—parts are returned to service quickly—new surface is often superior to original—

Almost any part that can be suitably positioned can be rebuilt by UNIONMELT welding. It has been used successfully on parts such as steel mill rolls, guides, mandrels, journals; wheels for locomotives, cars, and cranes; pipe molds, and press plungers and cylinders.



Rebuilding a 24 in. diameter press plunger.

Deposits of almost any thickness can be made of—

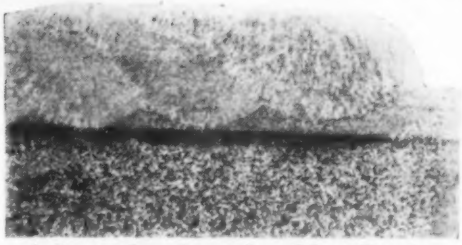
High carbon, flame-hardenable steels

Wear-resistant and hard-facing materials

Corrosion- and heat-resistant steels

With UNIONMELT electric welding, clean, dense, uniform weld metal can be deposited at the highest known welding speeds. There is no glare, flash, or spatter during welding. If a finished surface is needed, only minimum machining is required because of the smoothness of the weld deposit.

There are many LINDE methods of joining, rebuilding, forming, cutting and treating metals. LINDE Engineering Service can help you in production, construction, and maintenance. Just call the nearest LINDE office.



A flat surface is produced by offsetting each bead.

Linde
Trade-Mark

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

General Office: New York, N. Y. UCC Offices in Other Principal Cities

In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto

The words "Linde," and "Unionmelt" are registered trade-marks of The Linde Air Products Company

This **HOMESTEAD VALVE** opens or closes

instantly . . . every time . . . any time

IT'S STICK-PROOF

BECAUSE IT'S LEVER-SEALD

HOMESTEAD LEVER-SEALD QUARTER-TURN VALVES have been first choice for more than 16 years in services where extremes of temperature or pressure, or corrosive fluids, cause ordinary valves to "stick" or "seize".

They are "stick-proof" because built into each valve is a powerful lever-and-screw device that prevents sticking and assures positive action at all times under all conditions.

They operate faster too, than screw-stem type valves . . . 16 to 28 times faster. And the quarter-turn principle makes them ideal for installation in restricted areas, next to walls, floors, ceilings, congested piping and other obstructions where other types of valves could not be used. Next time you have a sticking or damaged valve replace it with a Homestead LEVER-SEALD Quarter-Turn Valve. You'll never be satisfied with ordinary valves again.

Homestead Lever-Seald Quarter-Turn Valves are available in metals and alloys to suit your needs in sizes from 1½" to 10" for pressures from vacuum to 1500 lbs.

- **Instant Stick-Proof Operation.**
- **Quarter-turn fully opens or closes.**
- **Seating surfaces always protected. Corrosion practically eliminated.**
- **Unobstructed straight-line fluid flow.**
- **All moving parts protected from effects of service conditions and weather.**

For full particulars send for "Valve Reference Book No. 39-3." Write today.

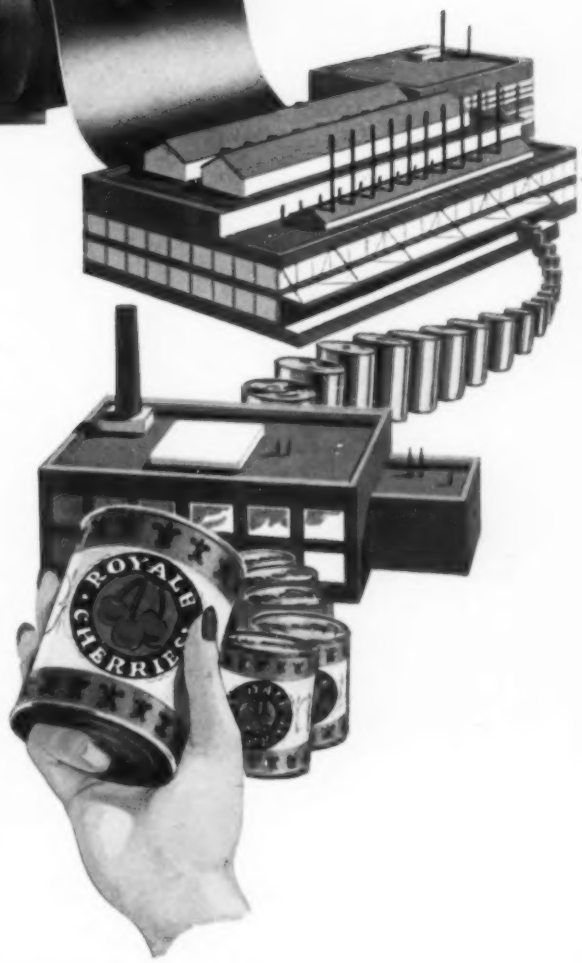
HOMESTEAD VALVE MANUFACTURING CO.

"Serving Since 1892"

P. O. BOX 21 **CORAOPOLIS, PA.**

UNITED

4-STAND TINPLATE MILL



The canning industry—America's largest user of tinplate—depends largely upon progress in the development of new and better steel rolling and coating processes to broaden its ever growing usefulness to the public.

One step in the process of making better tinplate for canning is the giant new United mill shown in operation. Designs for this, and other mills with production speeds up to 5000 feet per minute, are available for duplication, or for revision to suit your requirements. UNITED's engineers will be glad to confer with you concerning your plans for increased tinplate production.

U E & C D

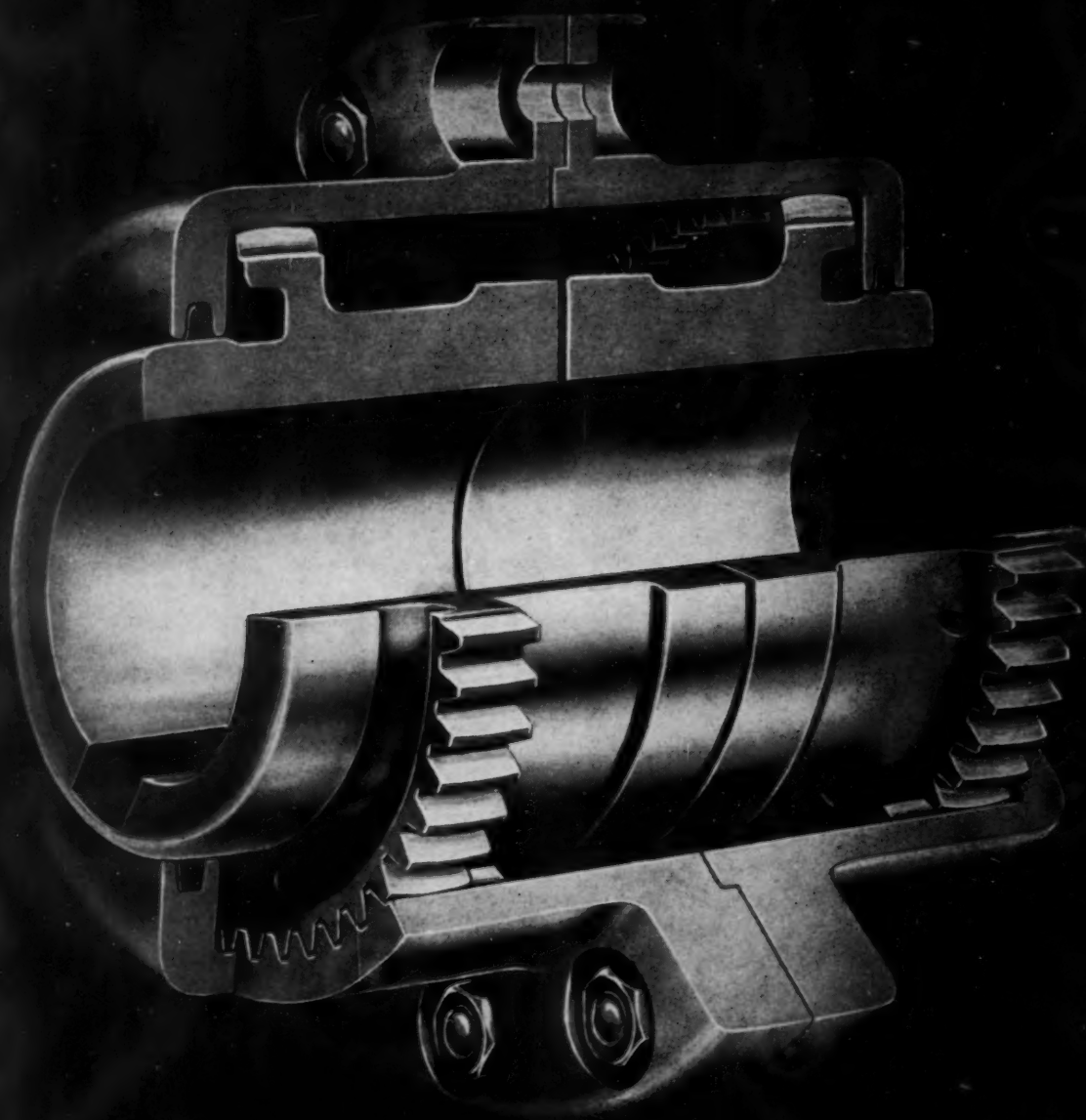
REG. T. M.

UNITED ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at Pittsburgh • Vandergrift • New Castle • Youngstown • Canton
Subsidiaries: Adamson United Company, Akron, Ohio
Lobdell United Company, Wilmington, Delaware
Stedman Foundry and Machine Company, Inc., Aurora, Indiana
Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P. Q., Canada
S. E. C. I. M., Paris, France

POOLE



OPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

LE FOUNDRY & MACHINE COMPANY WOODBERRY, BALTIMORE, MD.

SPECIAL TUBE MILL ROLL
AJAX DUPLEX ROLLS
SUPERIOR "X" ROLLS
LEWIS
LEWIS
ROLLS
"X" and "XA" ROLLS
SPECIAL PROCESS ROLLS
meet the most exacting Roll specifications
MANUFACTURERS OF
ROLLS AND ROLLING MILL MACHINERY
FOR THE IRON, STEEL AND
NON-FERROUS
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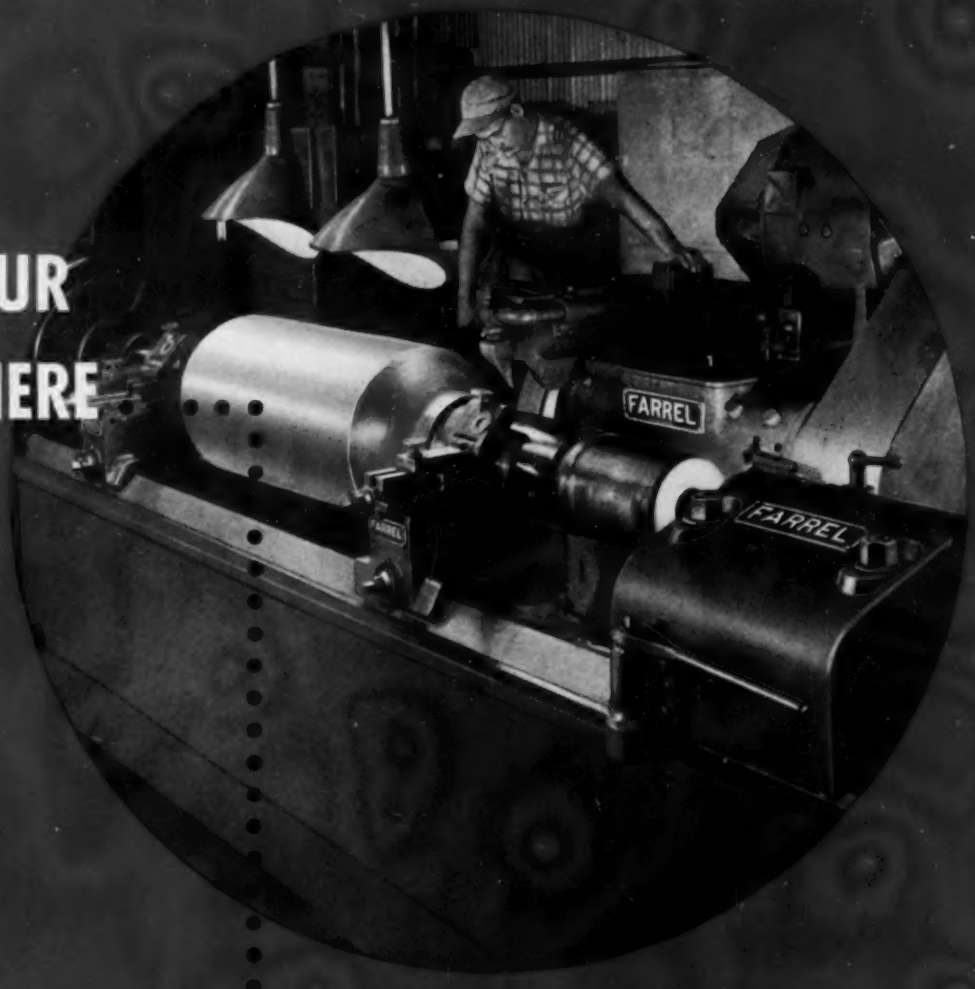
PLAIN CHILLED IRON ROLLS
ATLAS and ATLAS "B" ROLLS
CLIMAX and AJAX ROLLS
LEWIS FOUNDRY AND MACHINE DIVISION OF BLAW-KNOX COMPANY · PITTSBURGH, PA.

WHEN YOUR ROLL IS HERE



it is ground

Write for Bulletin No. 115 which describes in detail the many features of the Farrel Heavy Duty Roll Grinder. A copy of this 28-page bulletin will be sent to you without cost or obligation.

quickly

Reports from users of Farrel® Heavy Duty Roll Grinders indicate that with the latest type of machines they are able to cut roll grinding time substantially. This is so for both heavy roughing and fine finishing.

flawlessly

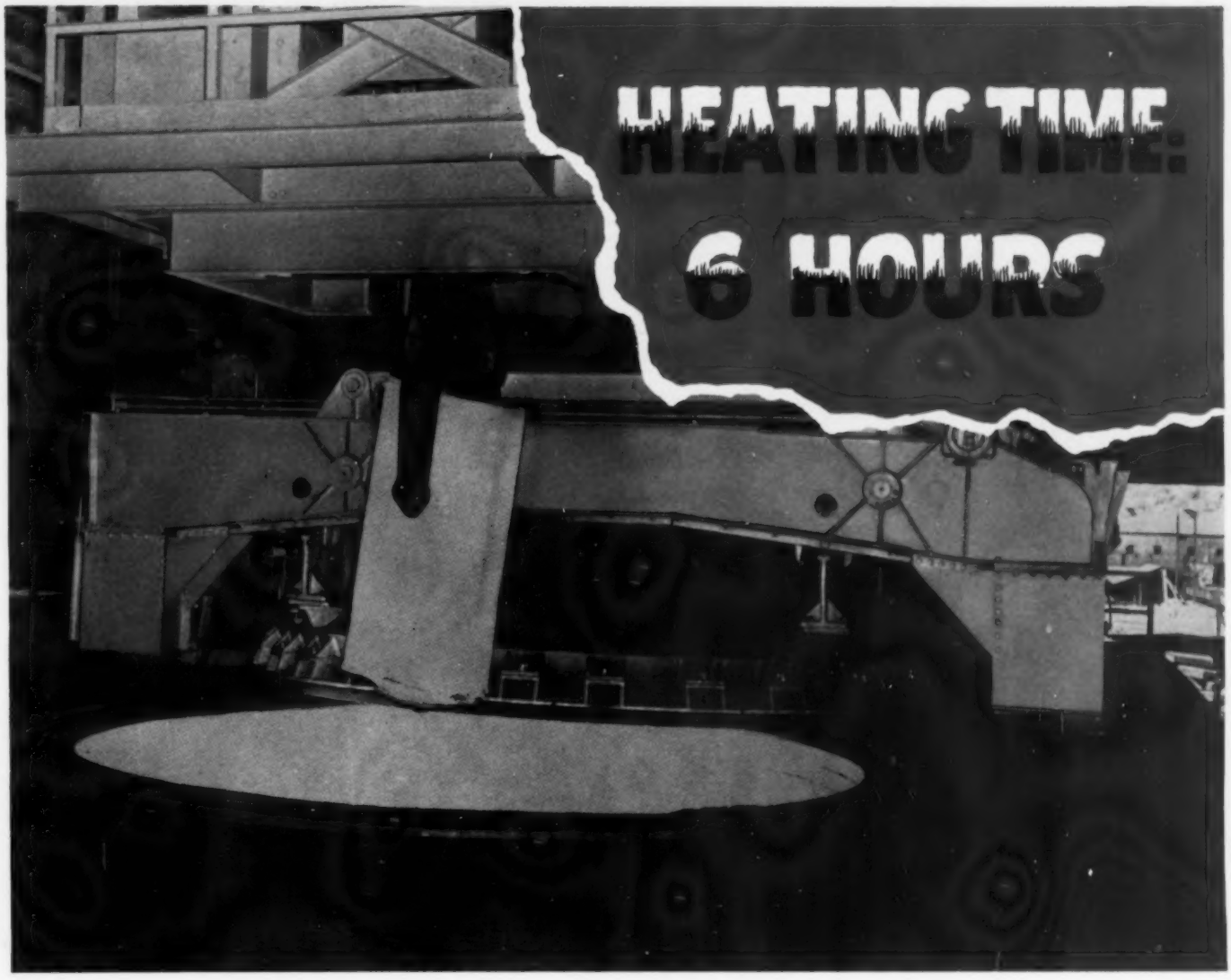
Rolls are obtained with a perfect surface free from marks of any kind, either straight or with concave or convex contours ground to exact symmetry and accuracy.

economically

Faster grinding means increased productive capacity of the machine and less labor per roll ground. In addition, the rolls have longer life because the exceptionally smooth and vibration-free action in roll, wheel and traverse drives means less metal has to be removed to clean up a roll in roughing and finishing operations. This is a vital factor in reducing the frequency of roll replacement and, consequently, the cost of new rolls.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONNECTICUT
Plants: Ansonia and Derby, Conn., Buffalo, N. Y. *Sales Offices:* Ansonia, Buffalo, New York, Pittsburgh, Akron, Chicago, Los Angeles, Houston

Farrel-Birmingham®



Charged black-cold, this six ton steel ingot and 11 others like it were heated to 2300 degrees in just six hours in this efficient Salem circular soaking pit. Hundreds of these circular soaking pits are helping the steel industry boost production around the world.

Salem's pits have an enviable reputation for uniform heating, operating economy, easy charging position and high quality production.

For complete details, write without obligation.

SALEM BUILDS

Salem circular soaking pits, rotary hearth furnaces, car bottom furnaces, forge furnaces, heat treating furnaces, gas atmosphere furnaces, air recirculating furnaces, needle metallic recuperators, continuous butt-weld furnaces and mechanical equipment for charging and discharging furnaces.

Salem Engineering Company

HEADQUARTERS FOR HEAT TREATING DESIGN

Salem, Ohio

SALEM ENGINEERING (CANADA) LTD., TORONTO, ONT.
SALEM ENGINEERING COMPANY, LTD., MILFORD nr. DERBY, ENGLAND

CRANES . . . FOR THE STEEL MILL

When your Steel Mill Cranes are "Shaw-Box," they contain advanced engineering and material values that insure reliable, efficient, low-cost crane performance. You have the extra advantages of "Shaw-Box" experience and precision manufacturing techniques.

Specialization in designing and producing Steel Mill Cranes has long been a "Shaw-Box" tradition. Working hand in glove with the Steel Industry, "Shaw-Box" research men and engineers have gained that intimate understanding of mill requirements which results in the excellent, rugged cranes steel men strive for in their specifications. Each "Shaw-Box" Steel Mill Crane is an outstanding example of the full interpretation that can be made of individual mill or AISE specifications. Built to exacting standards of fine workmanship, wear and resulting maintenance costs are extremely low — even under the most unfavorable and difficult operating conditions.

Mill operators all over the country have learned to depend upon "Shaw-Box" Cranes and the reliable, economical, trouble-free service they are built to give.

Be sure to send all your inquiries for Steel Mill Cranes and Soaking Pit Carriages to "Shaw-Box."

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

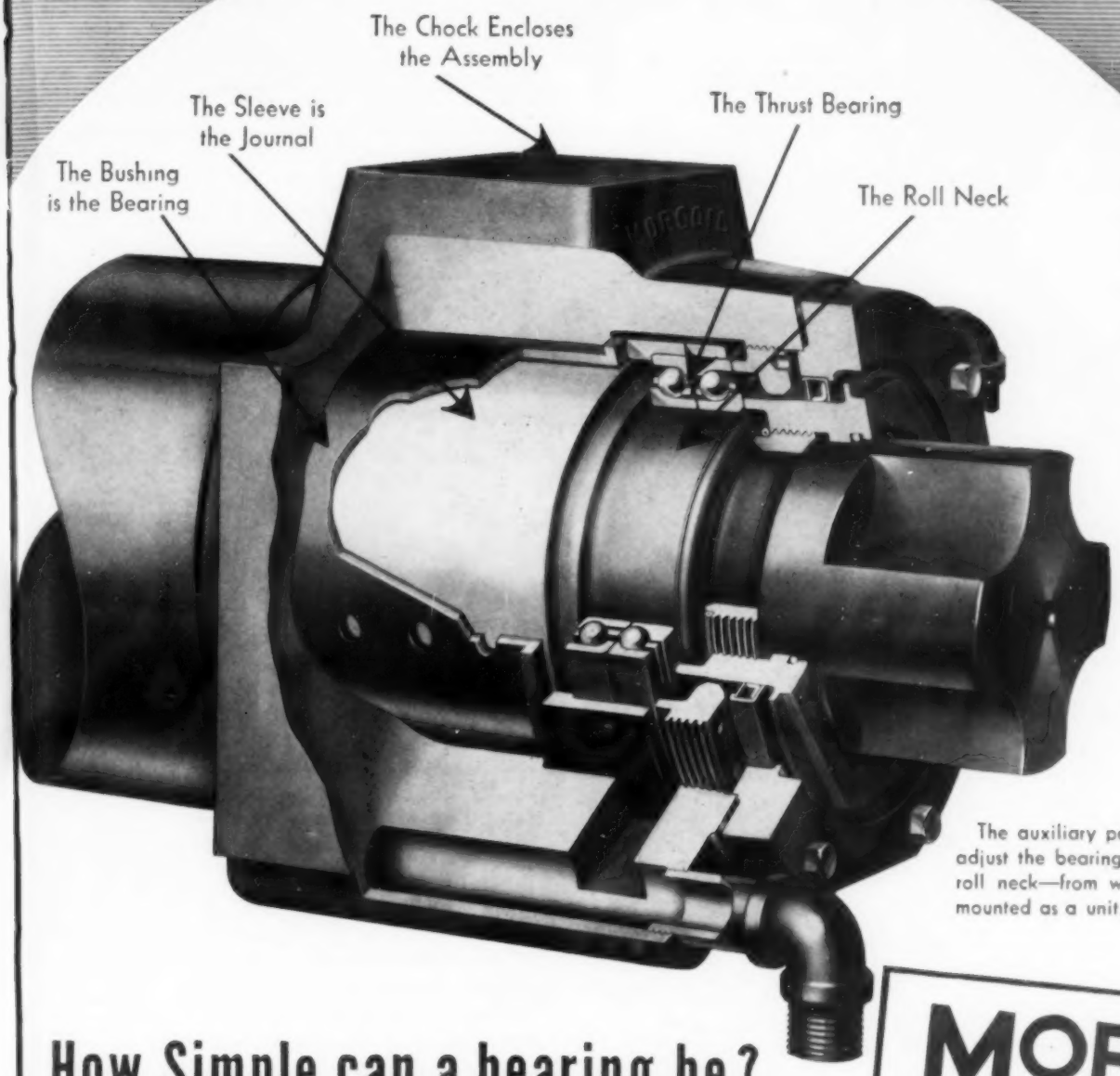
MANNING, MAXWELL & MOORE, INC.

SHAW-BOX CRANE & HOIST DIVISION

MUSKEGON, MICHIGAN

Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load-Lifter' Hoists and other lifting specialties. Makers of 'Asheroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, 'American' Industrial and 'Microsen' Electrical Instruments.

MORGOIL
ROLL NECK BEARINGS



The auxiliary parts serve to seal and adjust the bearing and secure it to the roll neck—from which it is easily dismounted as a unit.

How Simple can a bearing be?

One reason for the high efficiency of Morgoils . . . and their low operating and maintenance costs . . . is their extreme simplicity of design. Each part is there for a purpose . . . and each contributes to make Morgoils the most widely accepted roll neck bearings.

MB 13

MORGAN
WORCESTER

Rolling Mills · Morgoil Bearings · Wire Mills
Gas Producers · Air Ejectors · Regenerative Furnace Control

MORGAN CONSTRUCTION CO.
WORCESTER, MASSACHUSETTS

English Representative: International Construction Company
56 Kingsway, London, W.C. 2, England

EXTREME PRESSURE

All production machinery will last longer — give better service — if the proper lubricant is used. That's why you will find it profitable to use high quality Tycol oils and greases in your plant.

There's a reason! No matter what your lubricating need — *EXTREME PRESSURE, high or low temperature, high speed or any other service condition — there's a Tycol oil or grease suited to your specific requirements.

Refined from the highest grade crudes, Tycol lubricants are exceptionally resistant to breakdown which means greater economy . . . longer machine life for every type of equipment.

Tide Water Associated will gladly recommend the Tycol lubricant that meets your particular requirements. Call, write or wire your nearest Tide Water Associated office today.

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INDUSTRIAL LUBRICANTS

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TIDE WATER ASSOCIATED OIL COMPANY

17 BATTERY PLACE · NEW YORK 4, N.Y.

***LEARN WHAT THIS PRODUCT CHARACTERISTIC MEANS TO YOU — READ "LUBRICANIA"** This informative handbook, "Tide Water Associated Lubricania," gives clear, concise descriptions of the basic tests used to determine important properties of oils and greases. For your free copy, write to Tide Water Associated Oil Company, 17 Battery Place, New York 4, N. Y.

REFINERS AND MARKETERS OF VEEDOL — THE WORLD'S MOST FAMOUS MOTOR OIL

Presenting— another member of outstanding merit in the CLARK CONTROL family...

In 1910 The Sundh Electric Company (later acquired by the Clark Controller Company) was the first manufacturer to develop a **FIRE PUMP MOTOR CONTROLLER** approved by Underwriters' Laboratories, Inc., The Associated Mutual Laboratories and other similar organizations.

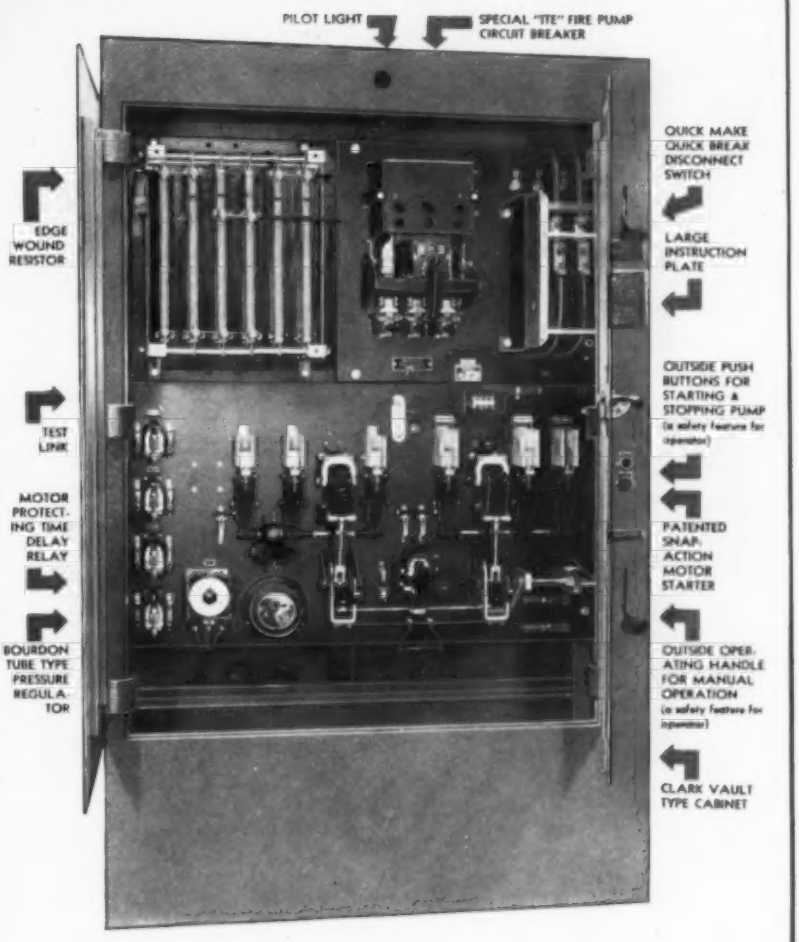
These 40 years have seen a steady development and refinement in design. The Bulletin 10650 Fire Pump Motor Controller is typical of the entire CLARK line of four types:

BULLETIN 10620, **NON-AUTOMATIC ACROSS-THE-LINE TYPE,** is for use with squirrel-cage motors.

BULLETIN 10630, **COMBINED NON-AUTOMATIC AND AUTOMATIC ACROSS-THE-LINE TYPE** is for use with squirrel-cage motors.

BULLETIN 10640 is **NON-AUTOMATIC, REDUCED VOLTAGE, PRIMARY RESISTOR TYPE.**

BULLETIN 10650 is as illustrated.


PILOT LIGHT
SPECIAL "ITE" FIRE PUMP CIRCUIT BREAKER
QUICK MAKE QUICK BREAK DISCONNECT SWITCH
EDGE WOUND RESISTOR
LARGE INSTRUCTION PLATE
OUTSIDE PUSH BUTTONS FOR STARTING & STOPPING PUMP (a safety feature for operator)
TEST LINK
MOTOR PROTECTING TIME DELAY RELAY
PATENTED SNAP-ACTION MOTOR STARTER
BOURDON TUBE TYPE PRESSURE REGULATOR
OUTSIDE OPERATING HANDLE FOR MANUAL OPERATION (a safety feature for operator)
CLARK VAULT TYPE CABINET

BULLETIN 10650 REDUCED VOLTAGE, PRIMARY RESISTOR TYPE, COMBINED NON-AUTOMATIC AND AUTOMATIC **FIRE PUMP MOTOR STARTER**

All types are available in a wide range of horsepower for 3 phase 3 wire, and 2 phase 4 wire.

CLARK Fire Pump Motor Controllers are extensively used in all types of industrial plants, warehouses, public and office buildings — wherever sprinkler systems, stand pipes, standby pressure areas, low-water pressures, dry-pipe installations require dependable pumping facilities.

In all types of CLARK Fire Pump Motor Controllers, the activating devices, pilot lights, and instruction plate are mounted in the trim. All types also have an inside operating handle on the patented snap-action motor starter.

For complete details, ask for Bulletins 10620, 10630, 10640 and 10650

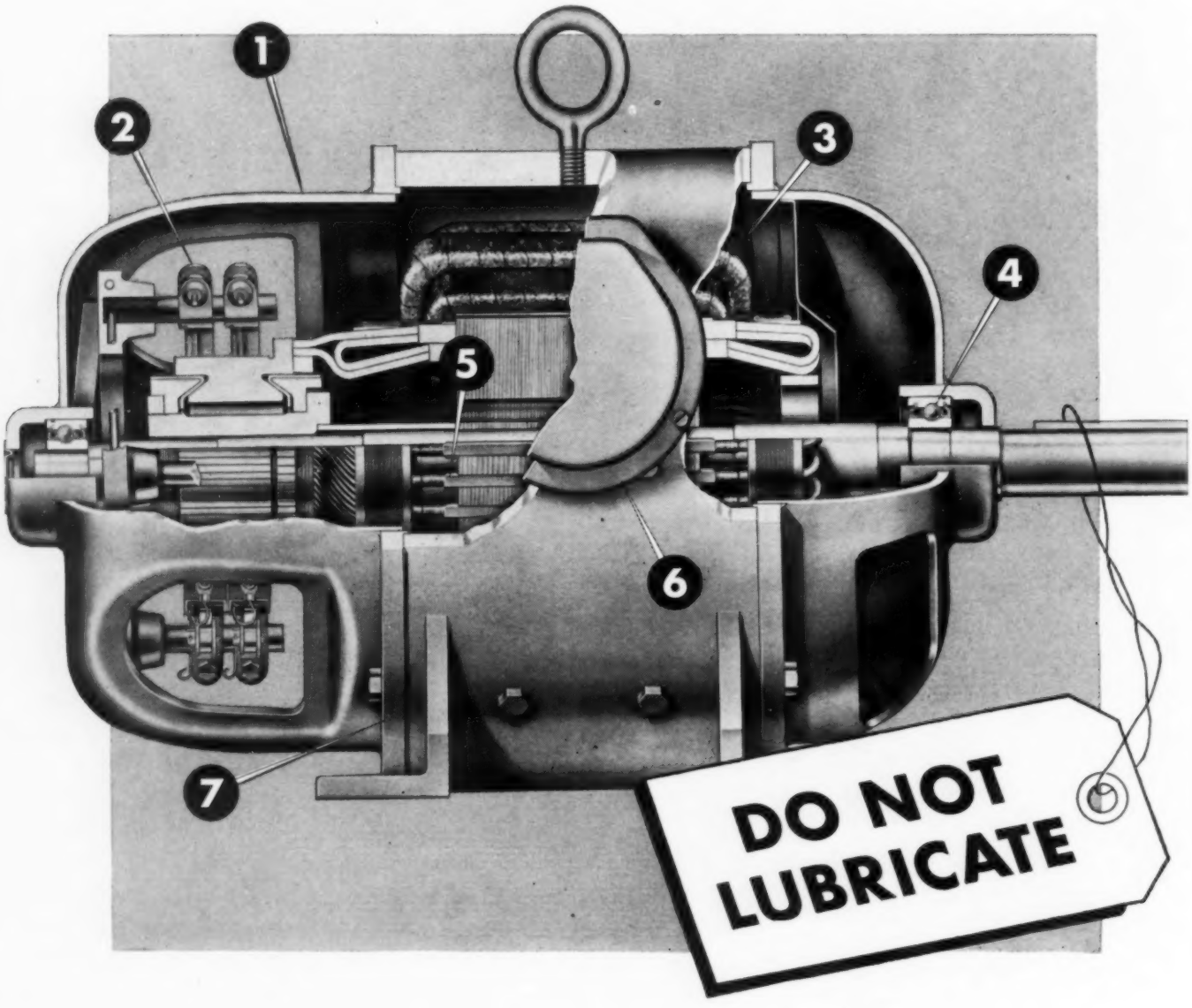
ENGINEERED ELECTRICAL CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152ND STREET, CLEVELAND 10, OHIO

YOU CAN BE **SURE**.. IF IT'S

Westinghouse



1. ALL-STEEL BRACKETS
2. INDIVIDUALLY REMOVED CAST BRASS BRUSHHOLDERS
3. SHELL-WOUND FIELD COILS
4. DOUBLE-SEALED PRE-LUBRICATED BALL BEARINGS
5. HEAVY-DUTY PRESHAPED ARMATURE COILS
6. STEEL-GASKETED CONDUIT BOX
7. ROLLED-STEEL FRAME

If you figure LIFE-COSTS . . . you'll figure LIFE-LINE

SK DEPENDABILITY
Wrapped in Steel
in the NEW Life-Line D-C MOTOR

Thirty-nine years at hard labor—in steel mills . . . in mines . . . in a thousand and one applications—have proved the dependability of the type SK d-c motor. Now, new dependability has been added—new motor stamina . . . new freedom from maintenance . . . new value for d-c motor users.

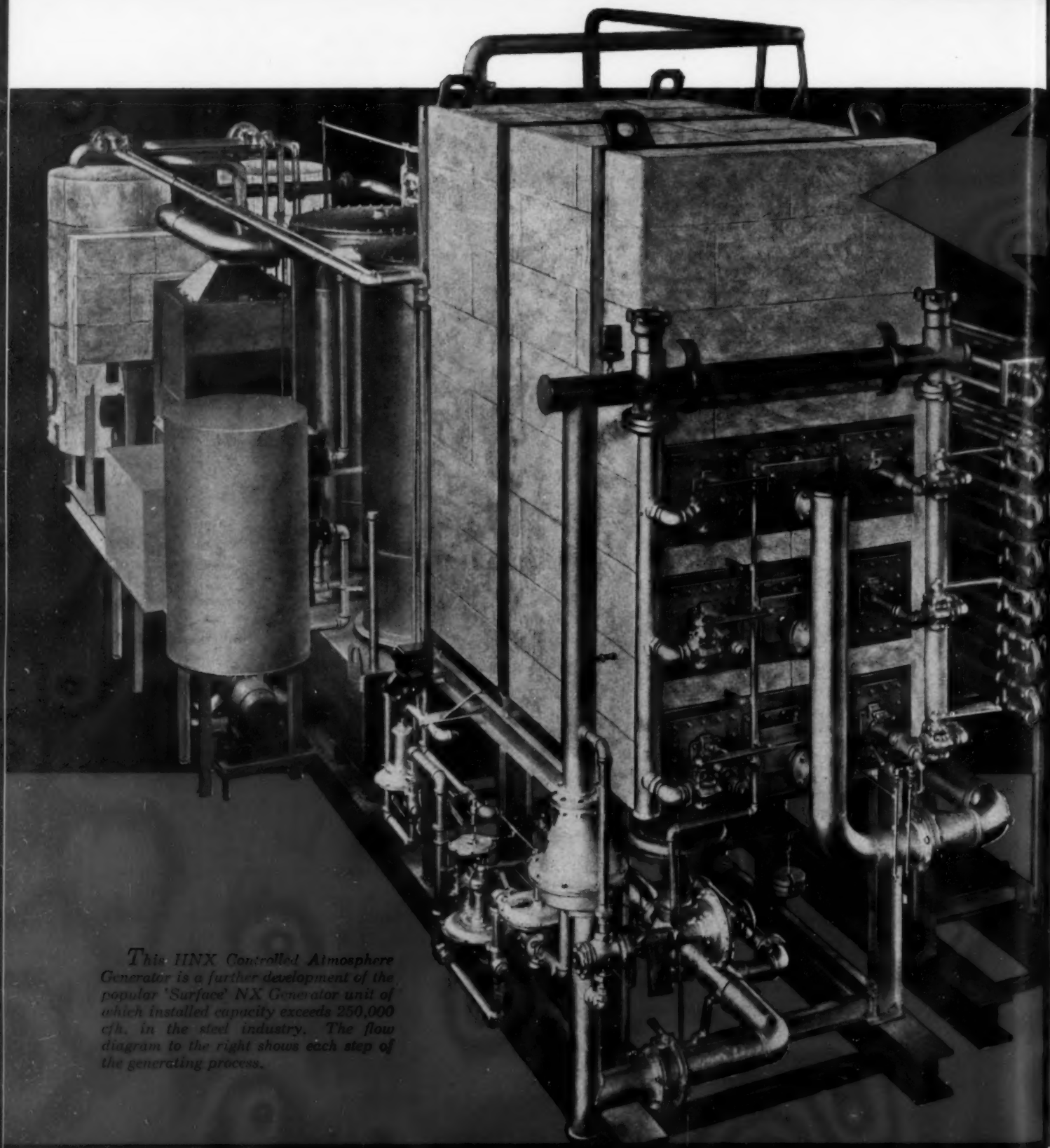
MAXIMUM STRENGTH AND RIGIDITY—Heavy steel end brackets and rolled-steel frame stand up to the shocking, jarring blows so often encountered in rugged d-c service.

SIMPLIFIED SERVICING—Readily accessible through spacious opening in front bracket, brushholders may be removed individually. Armature coils, wound from Tufvar wire and treated in Thermoset varnish assure long life . . . reduce trouble from shorts and grounds. Double-sealed pre-lubricated bearings (proved in over half a million motors) put an end to greasing problems.

INDIVIDUAL FIELD COIL UNITS—One coil may be replaced without expense of replacing all . . . or discarding pole piece. Just slip the new coil in place . . . save repair costs.

These are a few highlights of the new, all-steel Life-Line type SK d-c motor. Get the complete facts on series, shunt, or compound motors . . . frames 203-365 . . . in 1 to 30 hp ratings. Contact your local Westinghouse representative. Ask for a copy of "D-C Motor" Booklet B-4595, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21549

Westinghouse
Life-Line
D-C Motors



This HNX Controlled Atmosphere Generator is a further development of the popular 'Surface' NX Generator unit of which installed capacity exceeds 250,000 cfh. in the steel industry. The flow diagram to the right shows each step of the generating process.

SURFACE COMBUSTION CORPORATION • TOLEDO 1, OHIO

FOREIGN AFFILIATE COMPANIES

BRITISH FURNACES LIMITED—CHESTERFIELD
STEIN & ATKINSON, LTD.—LONDON

STEIN & ROUBAIX—PARIS, LIEGE AND GENOA
WILL L. SMITH, S.A.—BUENOS AIRES

One-Way Fired Soaking Pits

Billet Reheating Furnaces

Slab Heating Furnaces

Continuous Type, Controlled Atmosphere Strip Annealing and Normalizing Furnaces

Controlled Atmosphere Annealing Covers for Wire and Rod

Controlled Atmosphere Annealing Covers for Coil and Sheets

Continuous Furnaces for Heat Treatment of Steel Plate

Controlled Atmosphere Furnaces for Carbon Correction in High Alloy Rod and Bar Stock

Continuous Type Bright Annealing and Normalizing Furnaces

Prepared Gas Atmosphere Generating Equipment

Pit Type Convection Furnaces for Rod Annealing

Stress Relief Furnaces

Wire Patenting Furnaces

'Surface' HNX

CONTROLLED ATMOSPHERE

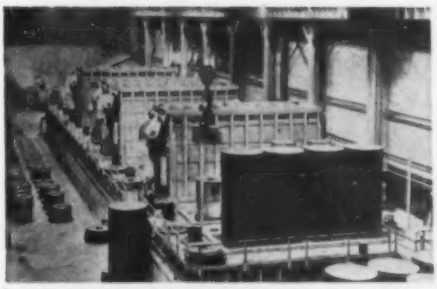
IMPROVES ANNEALING PRACTICE . . . PERMITS HIGHER STANDARD OF QUALITY IN STEEL MILL PRODUCTS

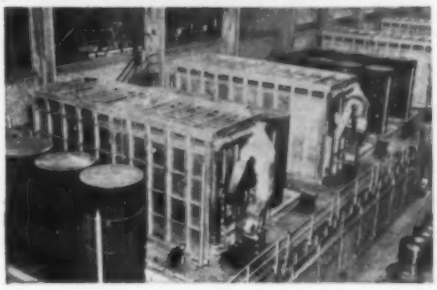
● HNX Controlled Atmosphere Gas is the newest modification of NX Gas and represents another step forward in research and development in controlled atmospheres for the processing of steel mill products. It is finding many applications where process requirements demand an inexpensive hydrogen-nitrogen protective atmosphere to assure top standards of quality.

Present applications of HNX Gas for the annealing of tin-plate stock have proved this atmosphere superior to others previously used, making possible a tin-plate stock of improved corrosion resistance. Eliminates "borders".

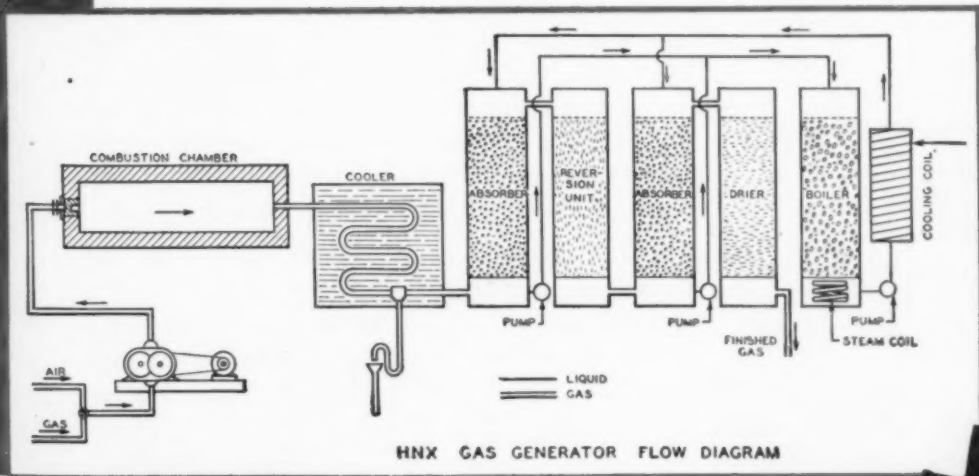
HNX Gas is not explosive and therefore serves as an excellent purge gas. At conventional mild steel annealing temperatures of 1150°F. to 1300°F. it provides complete surface protection for the steel when applied in the cover-type annealing furnace.

Invite a 'Surface' Engineer in for complete details.





Battery of 'Surface' lift-type annealing covers in a leading steel mill now using HNX gas for coil annealing.



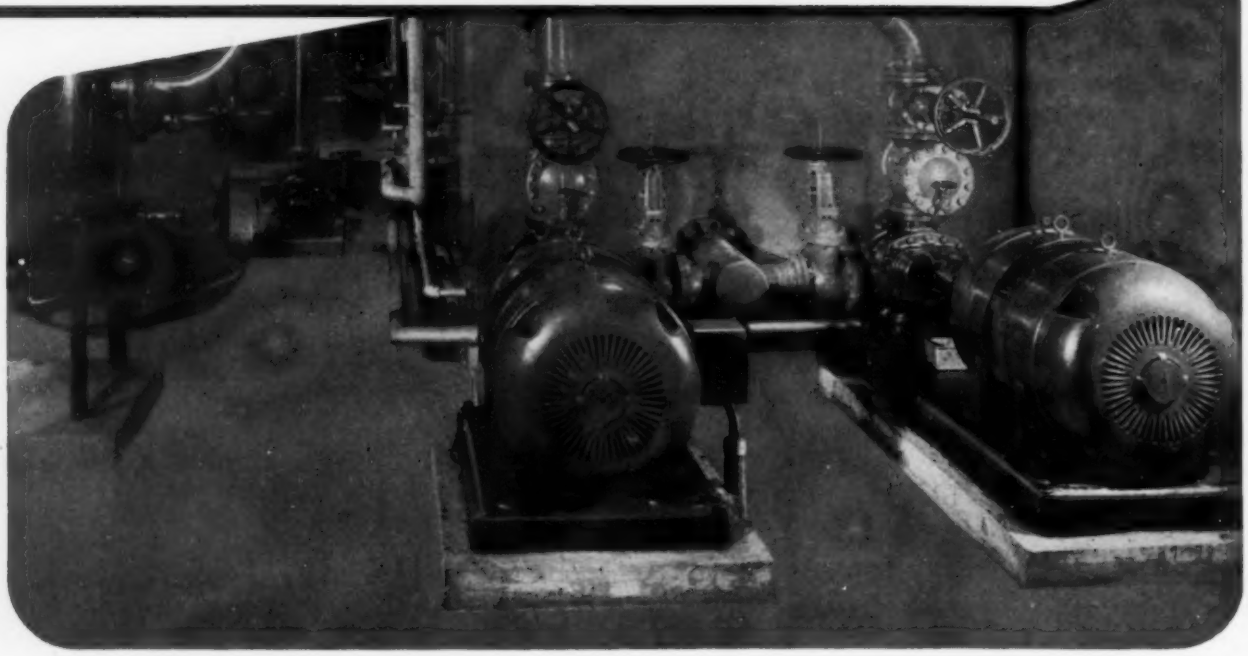
HNX GAS GENERATOR FLOW DIAGRAM

TYPICAL HNX GAS ANALYSIS

CO_2	Trace
CO	Trace
CH_4	Trace
H_2O	Dewpoint: (minus 40°F.)
H_2	3.0 to 10.0% (adjustable as required)
N_2	Remainder

'Surface' SERVES THE STEEL INDUSTRY

Greater Protection
for Vital Bearing Systems...



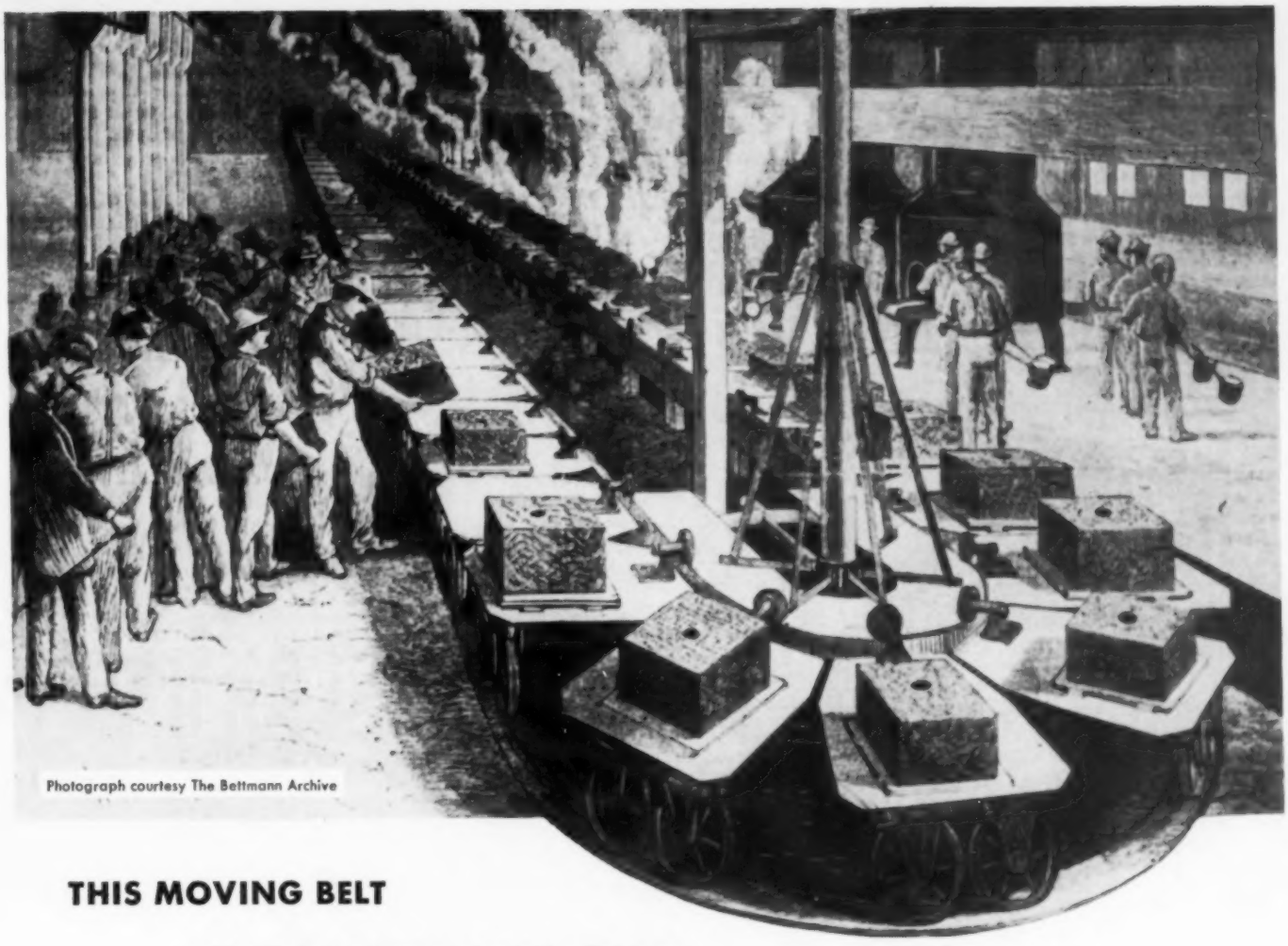
De Laval engineers know how to design a steel mill lubrication system that will offer the mill the maximum in bearing protection. This "know-how" starts with such fundamentals as applying the correct amount of lubricant to the proper point . . . knowing the most effective temperatures and pressures . . . and how best to meter the oil. But De Laval experience goes much deeper—takes all relative details into consideration—makes sure that the system is ***completely*** engineered. On one point De Laval is especially careful —to insure that every De Laval system is of large enough capacity to assure adequate cooling as well as efficiency of lubrication.

In De Laval Systems, purification of the lubricant is effected by means of the De Laval Oil Purifier. These machines, by centrifugal force, remove both solid and liquid impurities from the oil, and keep the rate of purification well in excess of the rate of contamination.

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, N. Y. 6 427 Randolph St., Chicago 6
DE LAVAL SALES & SERVICE, INC.
447 Fourth Ave., Pittsburgh 19
DE LAVAL PACIFIC COMPANY
61 Beale St., San Francisco 5

DE LAVAL
Engineered Systems

➡ PURIFICATION OF LUBRICATING OIL
➡ PROPER APPLICATION OF LUBRICANT
➡ CORRECT METERING FOR LUBRICATION
➡ EFFICIENT TEMPERATURE CONTROL



Photograph courtesy The Bettmann Archive

THIS MOVING BELT

WAS SENSATIONAL IN THE IRON and STEEL INDUSTRY

IN 1890!

Since the days of this antiquated conveyor system, outmoded methods, equipment, materials and services have been discarded to make way for new time and money saving improvements. "What's New" in the Iron and Steel Industry today will be exhibited at the Big Exposition in Cleveland this year. One good cost-cutting idea can more than pay for the time spent at this great show. You and every man in a supervisory capacity in your plant cannot afford to miss it.

Tickets are FREE! Write today for the number you need.

ASSOCIATION of IRON and STEEL ENGINEERS

1010 EMPIRE BUILDING · PITTSBURGH 22, PA.

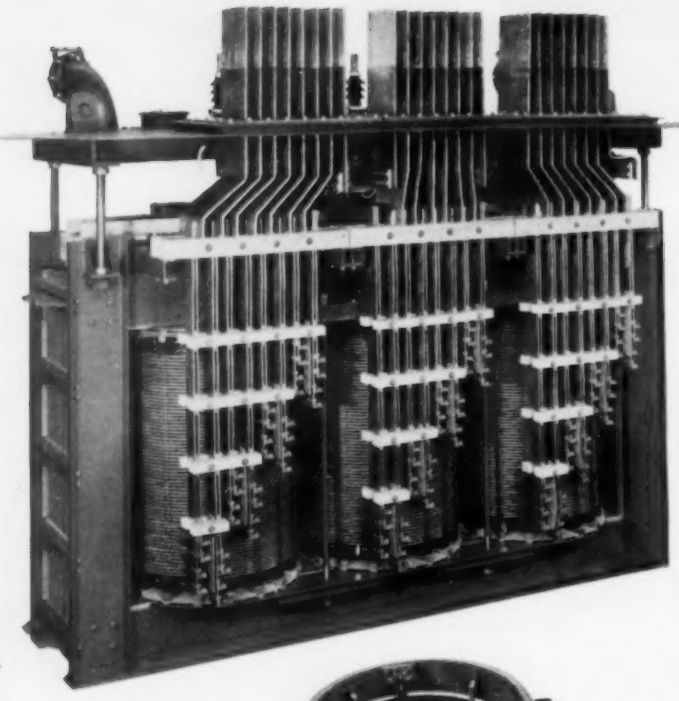
Can you afford to miss The latest 1950 Developments?

Be Sure to Attend the

IRON & STEEL EXPOSITION

CLEVELAND

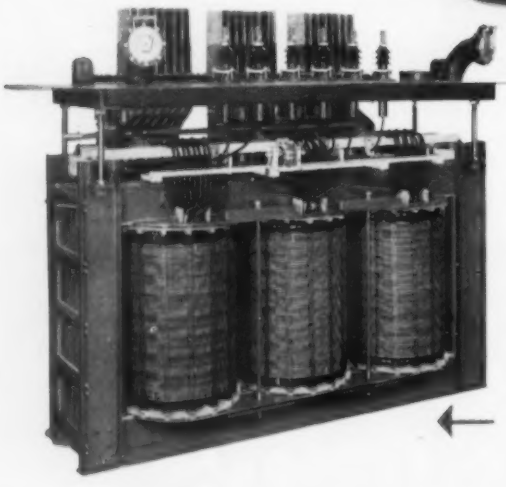
Sept. 26, 27, 28, 29



Low Voltage side. Note arrangement of bus bars.

12,000 Kva Furnace Transformer, 3 Phase, 60 Cycles, Water Cooled. High Voltage, 12,000 Volts. Low Voltage ranges from 375 down to 200 Volts, or full capacity. Maximum Low Voltage line current — 34,600 Amperes. High Voltage brought out with six bushings for star connection to obtain a lower range of low voltages.

Interior of tank showing arrangement of copper water cooling tubes.



High Voltage side. Pennsylvania's 3 Phase straight line tap changer mounted above core and coil unit can be quickly and easily inspected and maintained through cover manholes.

Recently installed 12,000 KVA Furnace Transformer raises total of PENNSYLVANIA FURNACE TRANSFORMERS in service to 1¼ MILLION KVA

When this 12,000 Kva Furnace Transformer was put into service, it brought the total installed Kva of Pennsylvania Furnace Transformers to over 1¼ million Kva.

The successful operation of Pennsylvania Furnace Transformers and their industry-wide acceptance indicate that Pennsylvania engineers fully understand the problems of electric furnaces and their relation to furnace transformers.

Pennsylvania TRANSFORMERS

Pennsylvania TRANSFORMER COMPANY

CANONSBURG, PENNA. • Greater Pittsburgh District

Cast UNIVERSAL COUPLINGS AND SPINDLES

give you these advantages:

1 Less Cost.. 2 Last Longer.. 3 Easier to Machine
4 Less Down-Time for Replacement

Those are not boastful claims, but the actual experience of many mill superintendents on the lookout for production economies. We welcome the opportunity to have you prove to yourself the advantages of Universal Couplings and Spindles cast from high-strength "Univan" or Armor Steel... Before your next replacement, let us give you the facts and figures on a "Union" casting to your exact specifications—either in the rough or completely machined.

"UNION" MAKES BETTER:

CHARGING BOXES... PEELS
INGOT CARS
CHARGING BOX CARS
COUPLING BOXES
AND SPINDLES
GEARS AND PINIONS
BLAST FURNACE BELLS
SPECIAL ALLOY CASTINGS
FOR ROLLING MILL EQUIPMENT

UNION STEEL CASTINGS

DIVISION OF BLAW-KNOX COMPANY... PITTSBURGH 22, PA.

ASKANIA
Solves Control Problems!

COMBINES ACCURACY, SIMPLICITY, STABILITY WITH DEPENDABILITY

HERE...

Soaking Pit . . . Since the first Askania Control was installed for a soaking pit at one of the large steel mills, *all pits* have been equipped with duplicates of the original control. Operation proved that Askania's accuracy over wide turndown range, safety, simplicity and ease of maintenance solved the control problem! Only Askania offered the ideal combination of all these features.

and HERE...

Gas Mixing . . . An Askania Control System for gas mixing was installed in a large midwestern utility company in 1937. Proving that Askania offered the best answer to this control problem, the company has since *standardized* on Askania Gas Mixing Controls.

Efficient, automatic, trouble-free operation of Askania Controls gives this utility company the results it requires.

and HERE again...

Chlorine Pressure . . . After the first Askania Control for chlorine pressure was installed in a large chemical plant, *several more* were ordered for this plant and others belonging to the same company.

The optimum combination of accuracy, dependability, low maintenance and ability to work with small pressures solved this company's control problem.

ASKANIA Controls

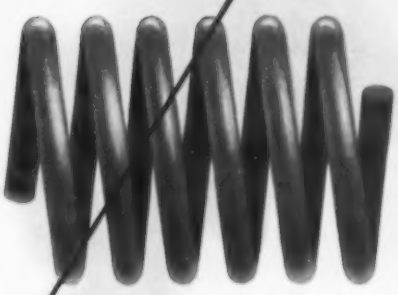
Find out how Askania offers the right combination of accuracy, dependability, simplicity, stability and safety . . . Find out how Askania can offer the best solution to your control problem . . . Send for Bulletin 139.

ASKANIA REGULATOR COMPANY

A SUBSIDIARY OF GENERAL PRECISION EQUIPMENT CORPORATION

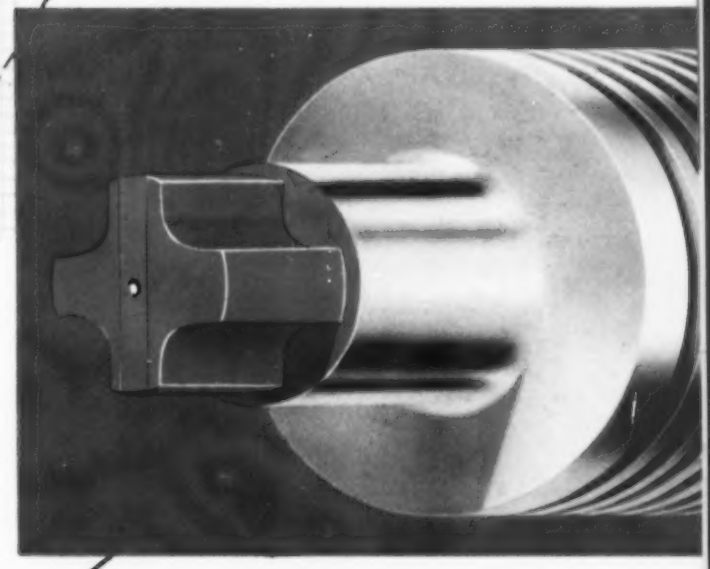
240 EAST ONTARIO ST., CHICAGO 11, ILL.

WIRE
HOLDS THE WORLD TOGETHER



THE WIRE INDUSTRY *in the U.S.A. traces its major development from 1831* when a small mill was set up in Worcester, Massachusetts. Within little more than a century the industry has become a major metal consumer requiring about five million tons annually of wire and rod mill products.*

**Mackintosh-Hemphill Company dates from 1803*



MACK-HEMP ROLLS for rod mills have been used by major steel companies since 1840. M-H engineers recently developed **GARRISON SPECIAL #1,** a new addition to the green-striped red wabbler family for rod production.

This new *deep-chill* roll has already proved itself in actual rod mill operation. Here's a real productioneering roll worth investigating today — Mack-Hemp's **GARRISON SPECIAL #1.** In fact, it's always worthwhile to keep an eye on what's new at Mack-Hemp.

MACKINTOSH-HEMPHILL COMPANY

Makers of the Rolls with the Striped Red Wabblers

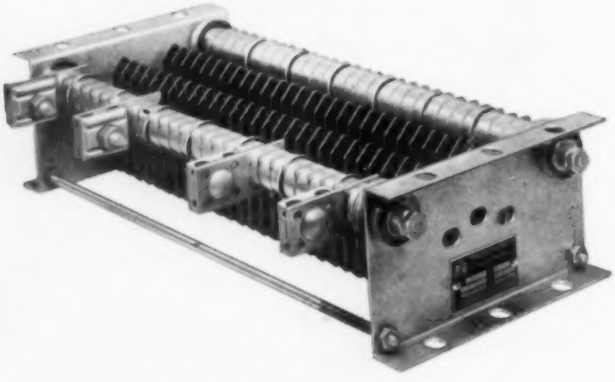
PITTSBURGH AND MIDLAND, PA.

MACKINTOSH-HEMPHILL PRODUCTS INCLUDE: rolls . . . steel and special alloy castings . . . completely integrated strip mills . . . heavy duty engine lathes . . . the new Mackintosh-Abramsen straighteners . . . improved Johnston patented corrugated cinder pots and slag-handling equipment . . . shape straighteners . . . end-thrust bearings . . . shears . . . levellers.

P-G *Steel Grid Resistors*

ARE BY COMPARISON SMALL UNITS... *but so important to production*

- Steel Construction
- Mica Insulation
- Corrosion Resistant
- Vibration Proof
- Moisture Resistant
- Provision for Expansion
- Adequate Ventilation
- Rugged Terminals



Resistors represent only a small part of a charging machine, but the duties they perform are of the utmost importance to its operation. In this stage of steel making, a charging machine must be able to start, stop, reverse and change speed regularly and continuously during its operating cycle. P-G Steel Grid Resistors have been handling their part of this job with a remarkable service record in many plants. For continuous "Trouble-Free Service" on this and all other steel mill applications, specify P-G.

Write for Bulletin No. 500

P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

NOW more power in the same size package

New

CROCKER-WHEELER
Form W Series 600
MILL MOTOR

The motor built to steel industry specifications

It's got the entire industry talking!

You wanted a more powerful motor, despite the limitations of crane and auxiliary service. Through better utilization of existing space, Crocker-Wheeler engineers were able to increase horsepower without adding to frame size.

You wanted a mill motor easy to get at for servicing. The rugged cast-steel split frame of the new Crocker-Wheeler Form W 600 Series is hinged for easy access to all motor parts.

You wanted longer service life . . . lower upkeep cost. Check the construction features of this auxiliary mill motor—see how thoroughly Crocker-Wheeler design meets your requirements. You'll find a few of these wanted features highlighted at right. For the complete engineering story that's making mill motor news today, write for Bulletin SL-620-1. Advertising Department, Elliott Company, Jeannette, Pa.

FIELD COILS wound on mold over mica cell. Mica washers at top and bottom of coil. Glass tape applied over cell, washers, and coil. Coil is filled layer by layer, during winding, with insulating compound that resists high temperatures, moisture and oil and provides an extremely homogeneous structure. The completely insulated coil is cemented to a steel spool, giving it complete support and rigidity. This design is a Crocker-Wheeler development, proved in previous C-W mill motors.

ARMATURE COILS Conductors are silicone-bonded, double-glass-covered wire. Slot portion of coil insulated with successive wrap of half-lapped glass-backed mica tape which extends around the coil bends and nose for reinforcement. Entire coil taped with closely woven glass tape, then dipped and baked in high-grade insulating varnish.

INTERNAL CIRCULATION Integrally-cast fan blades on rear coil support circulate air through core ducts and between field coils, dissipating heat to frame. Provision is also made for forced ventilation.

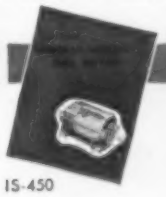
ELLIOTT COMPANY
CROCKER-WHEELER DIVISION

Ampere, N. J.

Branch Offices: Atlanta, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Houston, Kansas City, Los Angeles, Milwaukee, Minneapolis, New Orleans, New York, Newark, Philadelphia, Pittsburgh, St. Louis, Salt Lake City, San Francisco, Seattle, Tulsa, Washington, Wilmington. Representatives in principal cities.

LARGER MOTORS FOR MAIN ROLL DRIVE SERVICE, AND LARGE GENERATORS AVAILABLE FROM RIDGWAY DIVISION OF ELLIOTT COMPANY AT RIDGWAY, PA.

CW-4



ELLIOTT COMPANY,
Advertising Dept., Jeannette, Pa.

Please send Bulletin SL-620-1 on C-W Auxiliary Mill Motors.

IS-450

Name .....

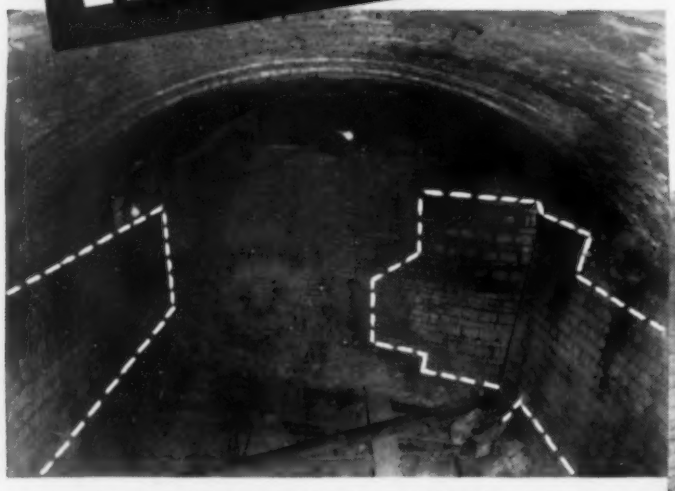
Title or Function .....

Company .....

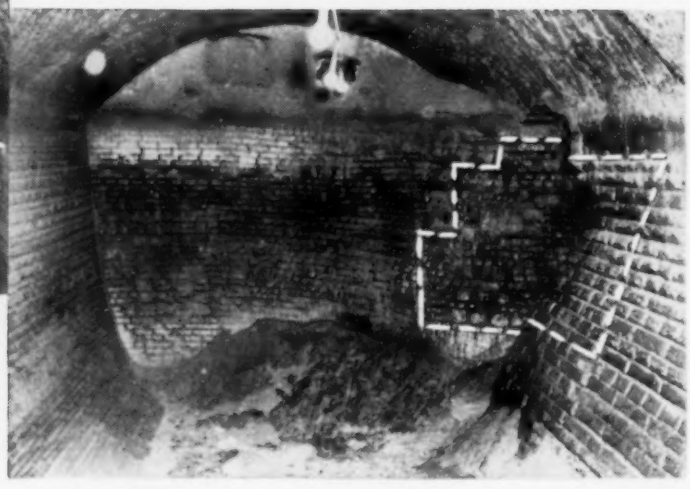
Address .....

COMBAT JOINT EROSION

and prolong hot metal mixer life with TASIL BRICK AND CEMENT



Area outlined in white shows TASIL brick laid in TASIL cement at start of campaign.



Same section after 6 months and 17 days of service, 259,000 tons through the Mixer. ONLY 25% of TASIL originally installed had to be replaced when repairs were made at the pour-in and pour-out areas. In previous campaign, fire clay brick lasted 3 months, 130,000 tons AND 75% replacement of original lining was necessary.

PROBLEM:

To lengthen the life of Hot Metal Mixer linings so that hundreds of tons of steel are not lost every day the Mixer is down for repairs.

SOLUTION:

Substitute TAYLOR SILLIMANITE (TASIL) brick and cement for blast furnace quality fire brick in the zones of excessive wear—the jambs and bottoms of the pour-out spot, and a band across the front and back walls and across both end walls.

PROOF:

Here's what the Masonry Superintendent of a large Steel Mill has to say about the lining of a 1000 Ton Mixer which had been "balanced" with TASIL in the weak spots and which set a new record for TIME IN SERVICE, TONS THROUGH THE MIXER, and a SAVING IN DOWN TIME AND REFRACTORY COST.

"Although the initial cost was high, the true cost of refractories should not be measured by the price of brick per thousand; the all-important item is the cost per unit of product. With this in mind, the reduced outage and the longer life justified the additional expenditure."

To keep hot metal available at the Open Hearth, call in the TAYLOR engineer in your district for a factual discussion of TASIL possibilities in your plant.

Refractorers to industry since 1864.

Exclusive Agents in Canada:
REFRACTORIES ENGINEERING AND SUPPLIES, LTD.
Hamilton and Montreal

TAYLOR — TAYLOR SILLIMANITE

The CHAS. TAYLOR SONS Co.

REG. U. S. PAT. OFF.

MANUFACTURERS OF REFRACTORIES • CINCINNATI • OHIO • U. S. A.

"Job-Engineered" means tailored to your crane needs

When you buy a crane, you want dependable service for many years to come. Your P&H "Job Engineered" crane will be built to meet your requirements to insure dependability . . . ample reserve capacity . . . adequate service factor . . . maximum safety. All P&H electrical equipment is designed and built by P&H for crane service — not adapted for it.

"Job Engineered" is an Added Value which comes with P&H's 65-year experience in crane-building — to serve your needs *exactly*.

And here's a fact worth remembering: P&H Cranes are sold and serviced by factory-trained men — not agents.

P&H Magnetorque* is the greatest advancement in AC crane control in the past 40 years. Ask about it.

*T. M. of Harnischfeger Corporation for electro-magnetic type brake.

EXCAVATORS • OVERHEAD CRANES • HOISTS • ARC WELDERS AND ELECTRODES • SOIL STABILIZERS • CRAWLER AND TRUCK CRANES • DIESEL ENGINES • CANE LOADERS PRE-ASSEMBLED HOMES

P&H

OVERHEAD CRANES

4455 West National Avenue
Milwaukee 14, Wisconsin

HARNISCHFEGER CORPORATION

Write for your copy of Bulletin C-39 describing P&H Magnetorque control.

OVER 17,000 P&H CRANES SERVE AMERICAN INDUSTRY . . . FAR MORE THAN ANY OTHER

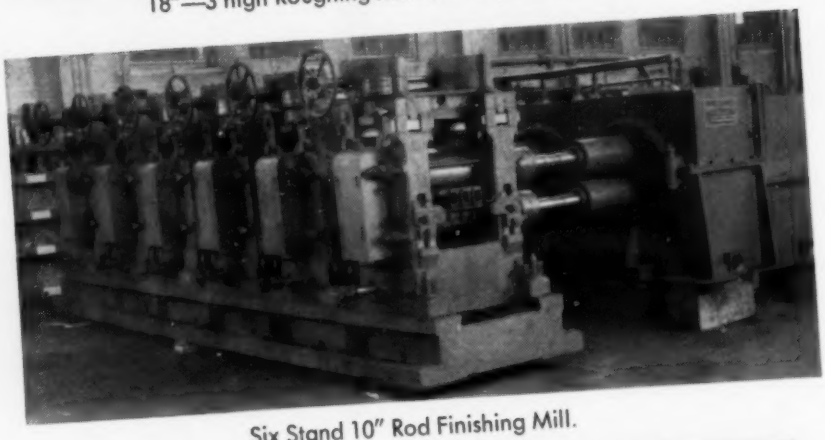
From Design to Installation—

Birdsboro is well equipped to engineer, to your exact requirements, steel mill equipment that will contribute to your greater production—and profit.

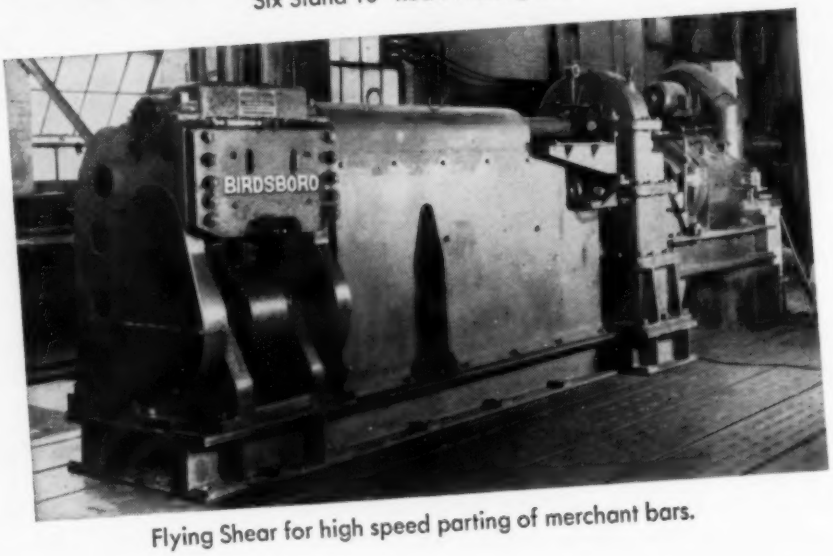
BIRDSBORO
ROLLING MILL MACHINERY

Ballers & Balers, Scrap
Beds, Cooling
Beds, Inspection
Bumpers, Furnace
Calenders
Cars, Ingot, Billet, Ladle, etc.
Coilers & Reels
Conveyors, Coil
Drives & Pinions
Ejectors, Furnace
Gauges, Shear, Saw, etc.
Guides
Handling Equipment (Kick-offs, Pilers, Cradles, etc.)
Lathes, Roll
Lathes, Slicing & Conditioning
Levelers, Plate
Machine, Flanging & Dishing
Manipulators, Mill, etc.
Mills, Blooming & Billet & Slabbing
Mills, Merchant & Bar
Mills, Plate
Mills, Rod
Mills, Sheet
Mills, Strip (Cold)
Mills, Strip (Hot) & Skelp
Mills, Vertical Edging
Mills, Ring
Planers, Plate
Pilers, Sheet & Plate
Pushers, Furnace
Repeaters
Rigs, Roll Changing
Saws
Shears, Alligator
Shears, Bloom, Billet, & Slab, Upcut, Downcut, Up-and-Downcut, Mechanical, & Hydraulic
Shears, Crop (Portable & Stationary)
Shears, Flying
Shears, Plate
Shears, Trimming and Slitting
Straighteners, Gag, Tables & Manipulators
Straighteners, Rotary
Stripping Machines, Ingot
Tables, Mill
Tables, Tilting & Lift
Tables, Transfer
Testing Machines, Pipe
Transfers

18"—3 high Roughing Mill with 2 speed main drive.



Six Stand 10" Rod Finishing Mill.



Flying Shear for high speed parting of merchant bars.

BIRDSBORO STEEL FOUNDRY & MACHINE CO. • BIRDSBORO, PA.

BIRDSBORO
STEEL MILL MACHINERY

OFFICES IN:
BIRDSBORO, PA. AND PITTSBURGH, PA.

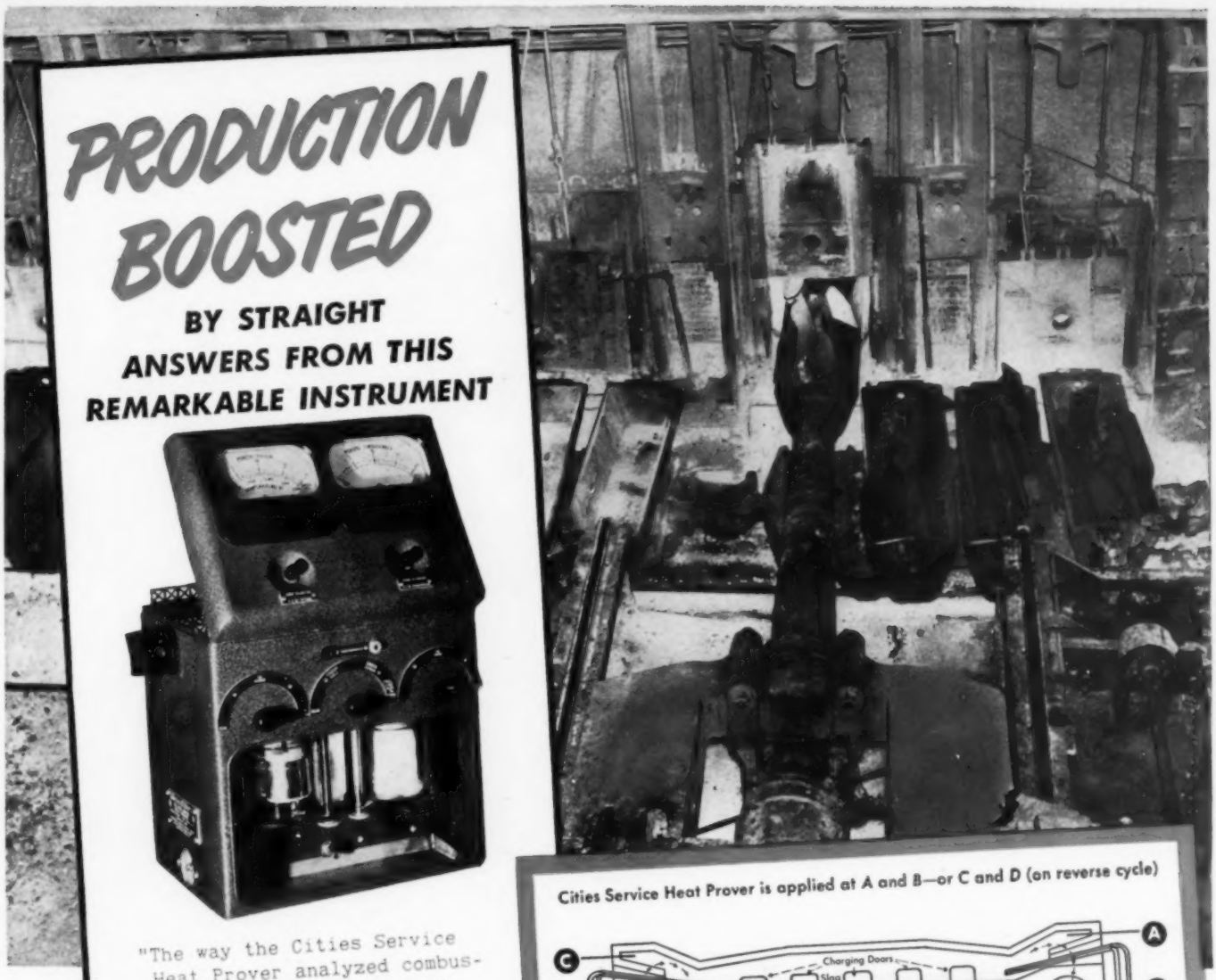
MM-7

DESIGNERS and BUILDERS OF: Steel Mill Machinery • Hydraulic Presses • Rolls • Special Machinery • Steel Castings • Crushing Machinery

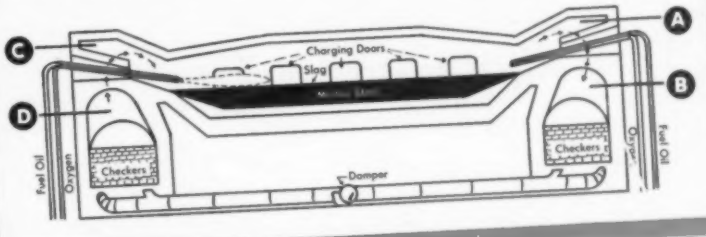
PRODUCTION BOOSTED

BY STRAIGHT ANSWERS FROM THIS REMARKABLE INSTRUMENT

"The way the Cities Service Heat Prover analyzed combustion atmospheres, we knew right off what to correct."
--Open Hearth Operator



Cities Service Heat Prover is applied at A and B—or C and D (on reverse cycle)



This highly developed flue gas analyzer gives correct reports on any type and size of furnace. Quickly, accurately and fully it lets you know how much fuel may be going to waste; whether there are combustibles, or excess oxygen to cause troubles like scaling; what combustion losses are due to useless heating of excess air. Corrections can then be made for added production efficiency. You can profit by this check-up service. Ask about arrangements.

For the Metal Fabricating Industry—
a complete line of petroleum products that includes:

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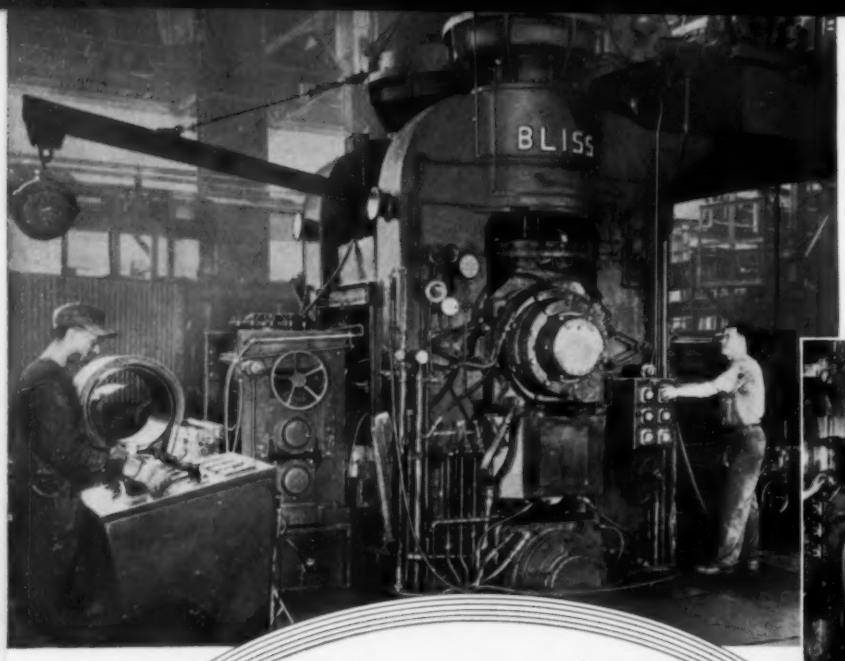
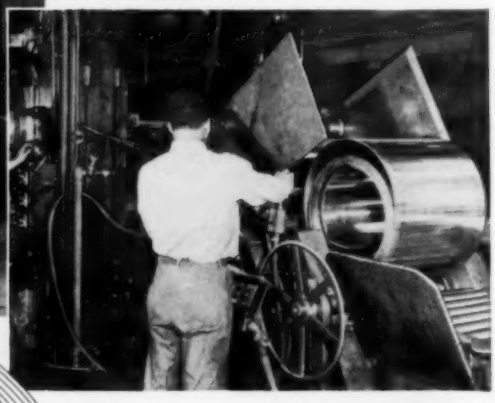


This 4-high breakdown mill—16" x 34"—brings ½" bars down to .057". Bliss pinch roll on the left feeds the heavy gauge metal into the work rolls. Magnetically operated screwdowns (two domes on top of mill) distribute pressure evenly on rolls.

Work is coiled on the *first pass*—at .365"—in this Bliss coiler. All work hereafter is from coil stock.



How Western's Connecticut Valley Mill Uses Bliss-Versatility

Copper breakdown from .080" coils, as well as rundown of other metals to .020" gauge, is done in this 4-high mill—10¼" x 34". Like the breakdown mill, it has screwdowns to distribute pressure evenly.

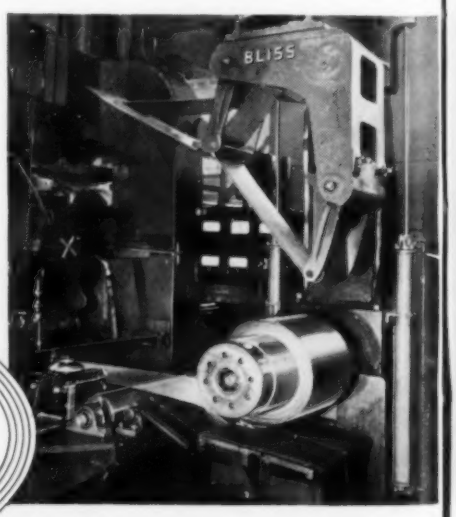
It is the proud boast of Western Brass Mills that *all* Western metals are "tailor-made" to customer specifications. This is true whether the metal is produced at the *Eastern* mill...located in the Connecticut Valley...or at the *Western* mill...located in the Mississippi Valley.

Pictured is the Bliss equipment that the Eastern mill uses to roll copper, brass, nickel, nickel brass, leaded or silicon brass, bronze, phosphor bronze, or leaded nickel to almost every conceivable gauge. Western Brass Mills, a division of Olin Industries, Inc., rolls metal to exacting specifications for a wide variety of our country's industrial leaders.

To supply four lines of 2-high finishing mills with this volume and variety of work keeps their Bliss 4-high breakdown mill and 4-high rundown mill working 'round-the-clock, day in and day out.

The breakdown mill—operating at 200 to 400 fpm—reduces ½" bars to gauges light enough for the rundown mill, usually .057". The teamwork of this mill and a Bliss coiler makes it possible to coil bars on the *first pass*—at .365". The mill, installed in 1942, has worked 40 hours a week. The rundown mill—in operation since early 1947—prepares the metal for the finishing mills, bringing it down to .020" at from 200 to 500 fpm.

It pays to put your problem up to Bliss. Call in a Bliss Engineer, today.



The rundown mill is equipped with a Bliss up coiler and tension reel with belt wrapper for heavy and light gauge coils. Tension reel wraps light gauge metal into tight, compact coils for easy handling.

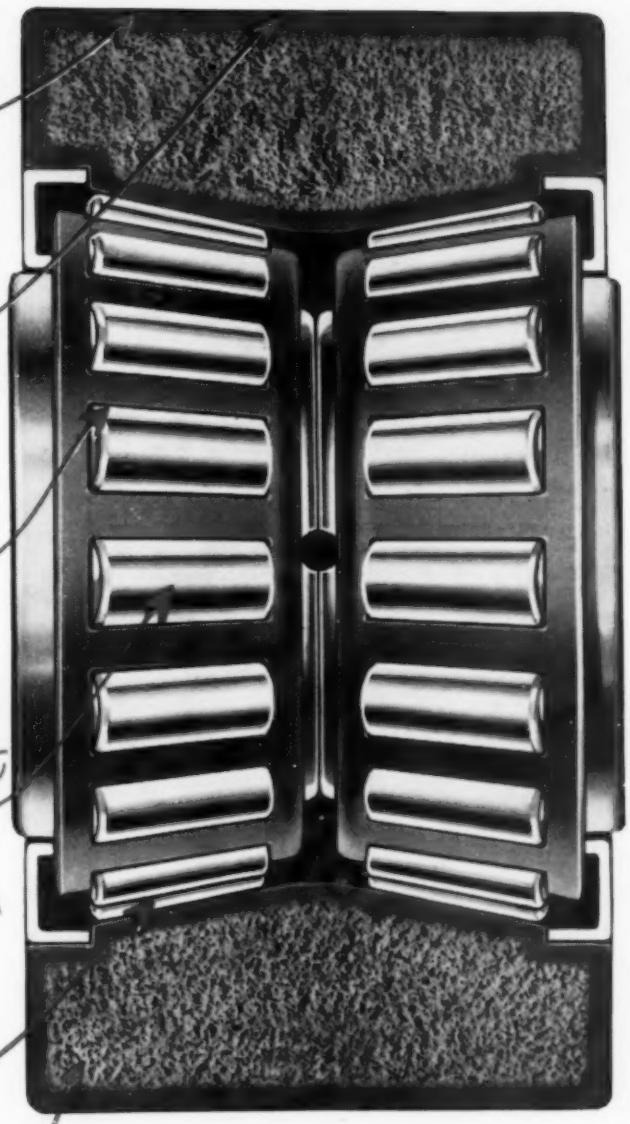
E. W. Bliss Co.

General Office: Toledo 7, Ohio

Rolling Mill Division

Salem, Ohio

Less scuffing and scoring in sheet levellers, with TIMKEN® bearings as back-up rolls


Surface is finished to 15 micro inches
Outer race of bearing itself forms the back-up roll
Friction practically eliminated
Tapered design reduces end movement
Line contact between rollers and races gives extra load capacity
Has extra heavy race

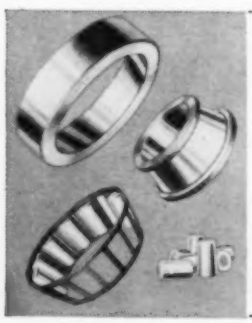
THE Timken® bearing shown here is especially designed to operate as a bearing and back-up roll, all in one! The outer race of the bearing itself forms the back-up roll.

With Timken bearings as back-up rolls in sheet levellers, marking of the sheets is reduced to a minimum. One reason is the almost complete absence of friction in Timken bearings. Timken bearings can be accelerated to top speed with minimum drag between rolls. This makes for less scuffing and scoring of the work rolls—less chance of marking the sheets.

Another non-marking feature of Timken bearings is their extremely smooth surface finish. Timken bearings for back-up rolls have a surface finish on the cup OD of 15 micro inches.

Timken bearings offer many other advantages for sheet levellers. Line contact between rollers and races gives them the extra capacity to take the leveller's tremendous radial loads. They permit tighter closures which retain lubricants better. They reduce wear on related parts. And they normally last the life of the machine.

Plan now to use Timken bearings as back-up rolls in your sheet levellers. For full information and engineering data on this application, write us on your company letterhead. And wherever you use tapered roller bearings, always insist on the trademark "Timken". The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".



DESIGN LEADERSHIP

The first Timken tapered roller bearing was produced in 1898. Since then the one-piece multiple perforated cage, wide area contact between roll ends and ribs, and every other important tapered roller bearing improvement have been introduced by The Timken Roller Bearing Company.

The Timken Company leads in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis steels.

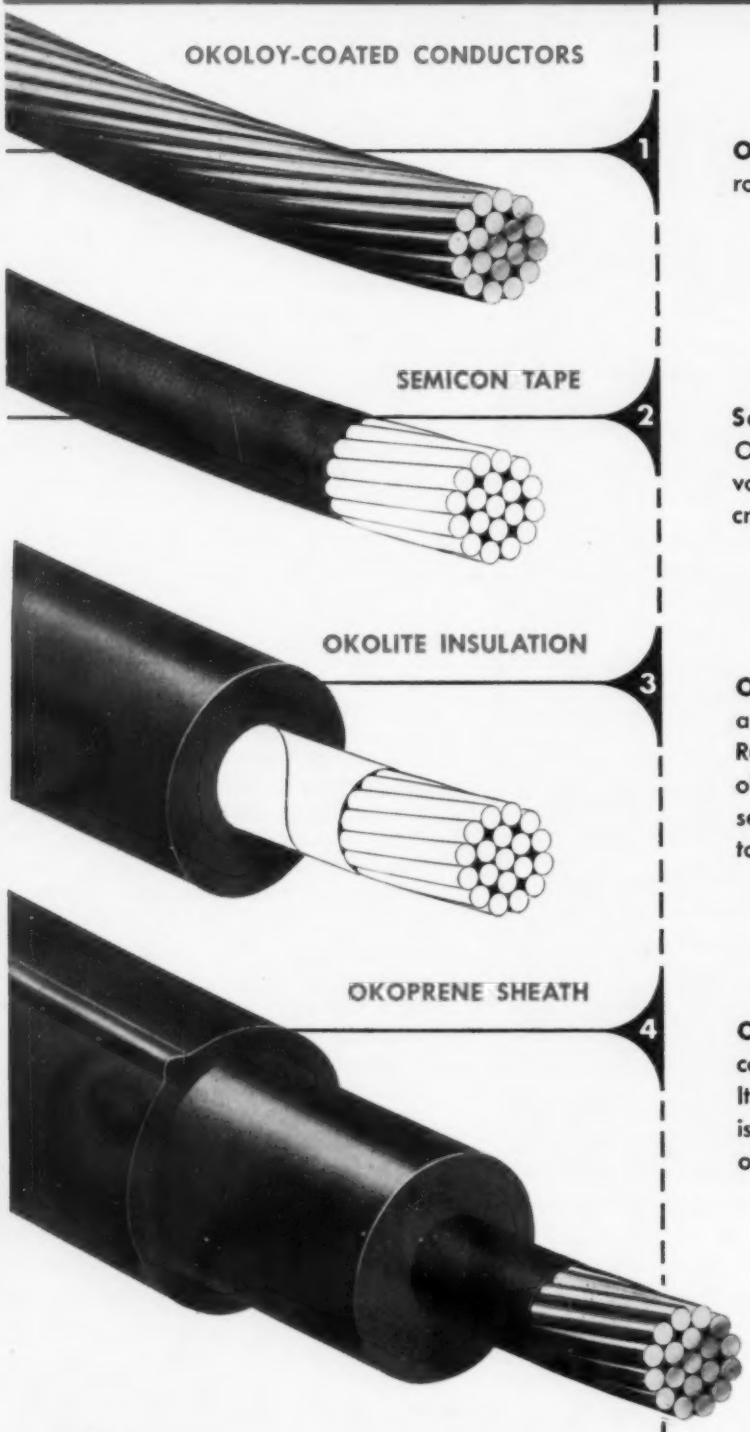
TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⬯ AND THRUST →⬯← LOADS OR ANY COMBINATION →✳←

4 reasons why OKOLITE-OKOPRENE CABLES EXTEND CIRCUIT LIFE



Okoloy coating on conductors—the special corrosion-resistant lead alloy that outlasts tinning 2 to 1.

Semicon tape over conductors—used in all Okolite-Okoprene cables operating at over 2,000 volts—eliminates internal corona cutting and increases dielectric strength.

Okolite insulation—moisture-resisting, high-voltage Okolite is made with Up-River Fine Para Rubber, the best grade of natural rubber. This oil-base insulation has been proved in years of service and is approved by Underwriters' Laboratories, Inc. as Type RWSN.

Okoprene sheath—the pioneer neoprene cable covering developed in the Okonite laboratories. Its life-extending durability and stable characteristics have been demonstrated on millions of feet of cable installations.

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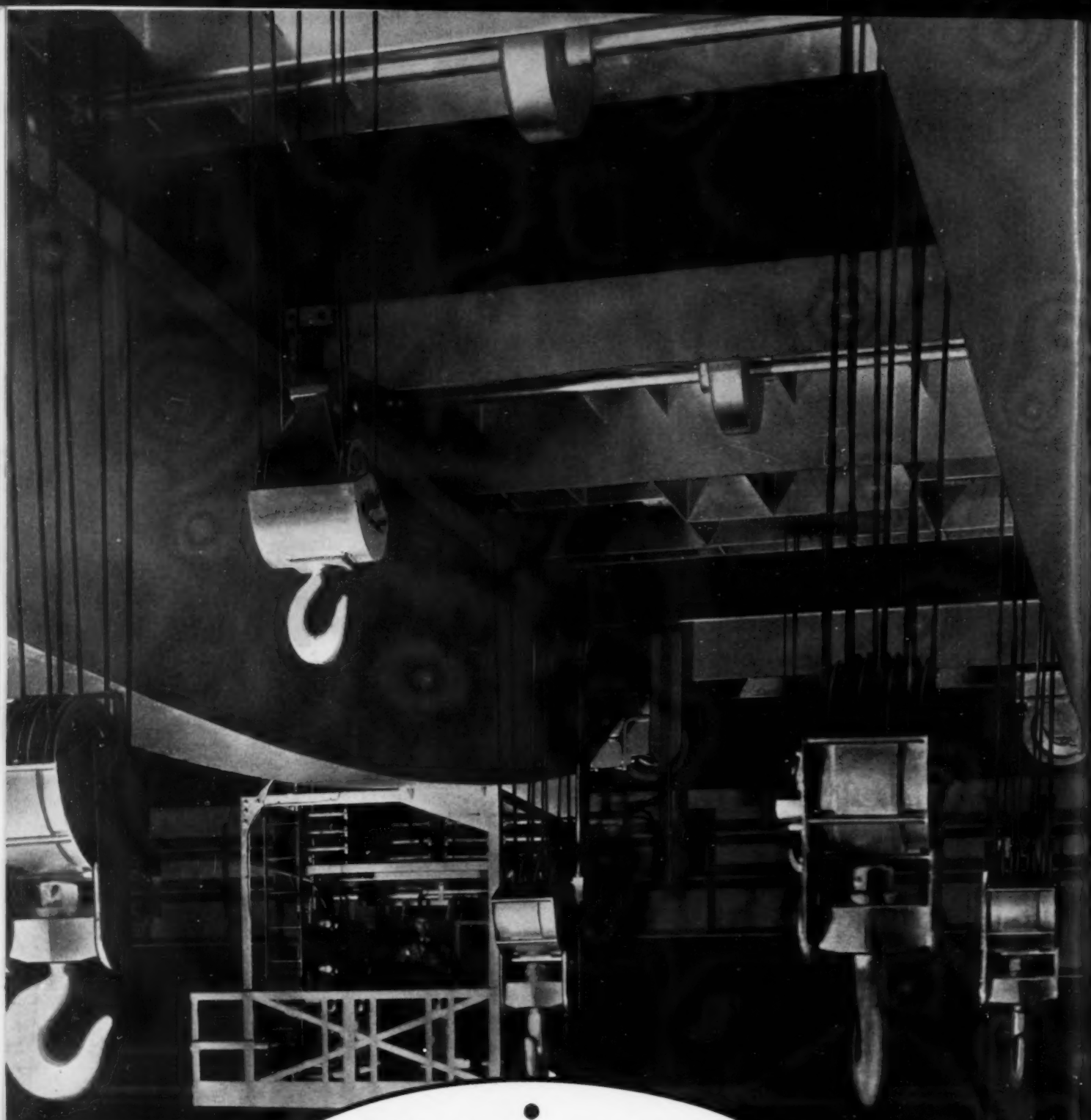

You may not find it in every school history but it's a fact that Cleveland has been building cranes since 1898 and it pioneered the all-welded crane in 1926.

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AFTER long hesitation and delay which to many seemed inexplicable, the steel industry has finally begun to fight the inaccurate, libelous attacks to which it has been subjected during recent years. The industry has apparently become convinced that it cannot maintain an air of dignified aloofness, ignoring the fly-by-night charges made against it or answering them eventually in stuffy statistics. Counter attacks against the charges of "monopoly," "reactionary," etc., have been in evidence in statements and speeches of the industry's leaders during the past two months. The Fairless talks in Baltimore and Boston, and his performance before the Celler committee in Washington, are an excellent start, full of punch and with a smattering of caustic humor and phrases. The reaction from both press and public is adequate testimonial to the new course.

▲

FURTHER indication of the new spirit is given in an address by Hiland Batcheller before the American Iron and Steel Institute last month:

"The steel industry is the focal point in an attack upon our individual freedoms and our system of free enterprise. Every politican and headline hunting theorist knows how cumbersome we are in our public relations thinking. Each of them has been well aware that he could attack us and by the time we got around to defending ourselves — if we ever did — it would be too late to adequately refute the charge or do us any good.

"Gentlemen, that is precisely what has been happening to the steel industry month after month, year after year. We have been feloniously assaulted on page one and replied three days later on page 23, or three months later in the financial section. And no matter how good our case may be, we can't win by fighting front page attacks on page 23."

▲

INDEED, well may the steel industry look to its fences. In the hearings before the Celler committee, the industry came out quite well. But it is no secret that the Justice Department is carefully preparing a case through which they will try to break up United States Steel Corporation, to be followed, if successful, by similar suits against Bethlehem, Republic, etc.

▲

ONE of the points which seems very important to government investigators is that four steel companies whose capitalization totals only half that of United States Steel earned more money than the larger company. This is, of course, not startling to those familiar with the industry. The combination of Youngstown Sheet and Tube, National, Inland and Armco has a capitalization approximately half of U. S. Steel's, and in 1948, they out-earned the big company. Whether or not this is proof of the inefficiency of large corporations, it does seem to prove that U. S. Steel is not a monopoly.

▲

AS spring turns everything green, including last year's Christmas jewelery, the development of a growth inhibitor for plant life becomes of more and more interest. Properly used, this product, which is called maleic hydrazide, can retard the growth of grass for six weeks, and can slow down a hedge so that only two cuttings per year are necessary.

The developers of this prospective boon say that manufacturers of lawn mowers and hedge shears won't have to worry for a long time, but we'd like to urge them to hurry completion of their experiments. Also, we'd like to pass on the suggestion that they experiment with the stuff in hair tonic and shaving lotion.

▲

THE season also makes particularly appropriate the following item by Cliff Walters which appeared in the column "Pepper and Salt" in the Wall Street Journal:

A kink in my back, I'm carried
Off to the chiropractor,
And wishing my wife had married
A bright young garden tractor.

▲

A BUILDING official has surveyed housing costs, and has come up with the conclusion that, if costs increase during the next 50 years at the same rate they have during the past 50 years, a five-room house will be selling for $30,000 in 1975, and for $60,000 by the year 2000.

With Truman promising a national income of $350,000,000,000 for 1960, and with the general inflationary tone of administration policies, we're inclined to agree with the prediction.

▲

IT isn't really true that ECA stands for Everybody Counts on America.

▲

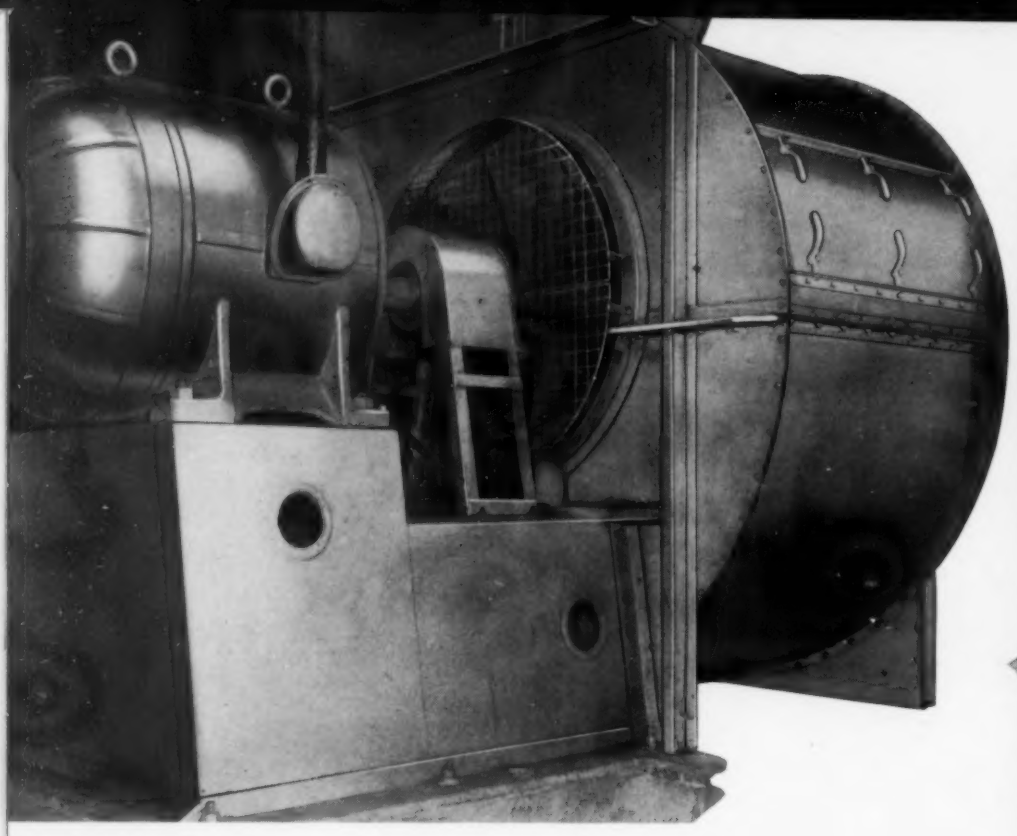
MAYBE the featherbrains who get all wrapped up in every "ism" except Americanism should give heed to the following paragraph from Le Populaire, leading French socialist newspaper: "American capitalism has made American workers the best fed, best dressed and best supplied with luxuries of any worker in the world. Only three things are wrong with the workingman's life in the United States: He eats too much, suffers from a housing shortage, and continually runs into debt."

▲

AND maybe those individuals who moan about the unequal distribution of this world's goods should remember that nature provides plenty of food for every bird, but she doesn't toss it into the nest.

▲

A LOT of things in this world seem unfair. For example, a banker may write a bad poem, but a poet isn't allowed to write a bad check.



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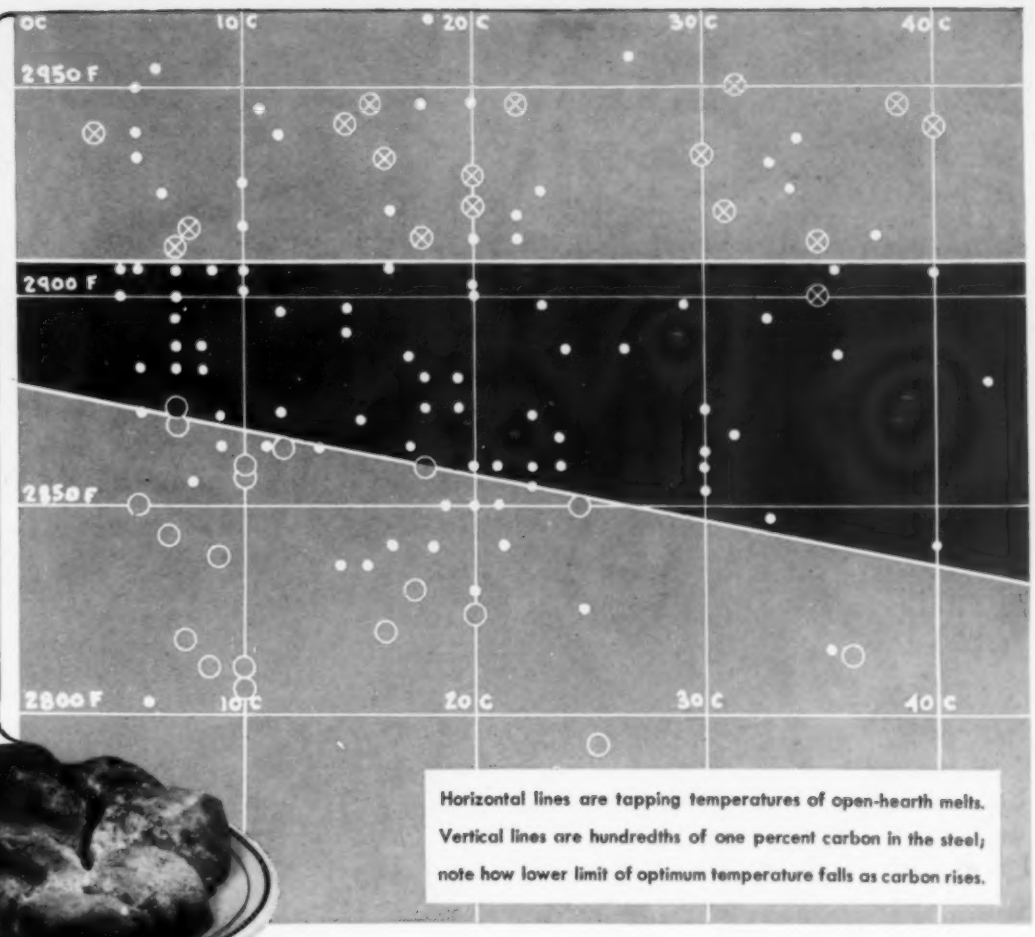

Horizontal lines are tapping temperatures of open-hearth melts. Vertical lines are hundredths of one percent carbon in the steel; note how lower limit of optimum temperature falls as carbon rises.

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In This Issue

Pass Design of Angular Sections — by Ross E. Beynon, Superintendent, Roll Shop Dept., Carnegie-Illinois Steel Corp., South Works, Chicago, Ill. 53

Problems of Air Pollution — by Allen D. Brandt, Industrial Hygiene Engineer, Bethlehem Steel Co., Bethlehem, Pa. 75

Controlled Cooling of Steel Blooms in Car Bottom Furnaces — by Charles J. F. Burch, Supervisor Design, OH and Electric Furnaces, Carnegie-Illinois Steel Corp., Duquesne, Pa. 86

Electric Equipment for High Speed 2-Stand Temper Pass Mills — by R. E. Marrs, Steel Mill Division, General Electric Co., Schenectady, N. Y. 95

Electric Arc Furnace Steel Quality — by Robert Sergeson, Chief Metallurgical Engineer, Rotary Electric Steel Co., Detroit, Mich. 100

The Mill Motor After Forty-Five Years — by S. S. Burns, Crocker-Wheeler Electric Manufacturing Co., Division of Elliott Co., Ampere, N. J. 105

AISE Standard No. 8 (Tentative) Crane Wiring Standards 115

Electric Weld Tube Mill Goes into Production at National Tube Co.'s McKeesport Works 120

AISE Revises By-Law 122

Date-Line Diary 127

Industry News 131

Personnel News 145

Equipment News 157

Publication Service 169

AISE New Members 173

Index to Advertisers 175

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WHEN YOU MELT... MOORE RAPID **Lectromelt**

Pass Design of Angular Sections

By ROSS E. BEYNON
Superintendent, Roll Shop Dept.
Carnegie-Illinois Steel Corp.
South Works
Chicago, Ill.

ROSS E. BEYNON

. . . . with this discussion on angular sections, Mr. Beynon adds an eighth chapter to his previous comprehensive papers which dealt with bar mills, blooming and billet mills, structural mills, rail mills, rod mills, basic rolling principles, and beam and channel roll design . . . .

▲ SECTION rolling started with the production of angles sometime between 1800 and 1819. Confirmation of early rollings of angles is found in the reports of visitors to England in 1822 who saw angle iron rolls in the mills and noted that they had been in use for a considerable period of time. Samuel Leonard of Pittsburgh is said to have rolled the first angle in this country in the year 1819. The French, who were pioneers in iron building construction, used angles extensively in their work, and it is possible that they also may have been the pioneers in rolling angles.

The reluctance of the early roll designers and mill operators to use anything in the nature of a hanging guide led them to roll their angles with the apex down so that resting guides could be used with the two-high mills of the period.

The roll housings of the original Cort mills were very crude in design, and it is hard to picture sections being rolled accurately in roll housings of the type used. It would be especially difficult to roll angles with the side thrust encountered on these sections.

Drawing 1 shows an early type mill roll housing. The mill in which this housing was used was built at Wortley, England in 1790, and its construction was supervised by Henry Cort and his workmen. While this rolling mill was crude it was capable of rolling twenty times the product produced by the hammer method which preceded it.

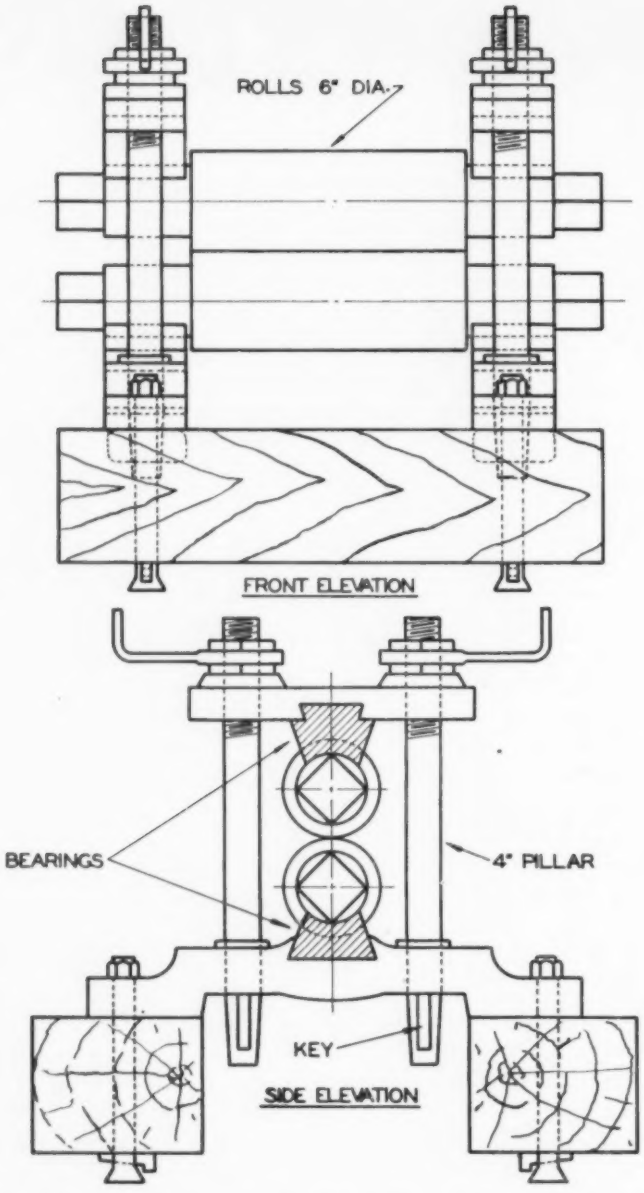
Illustrated in Drawing 2 is a pioneer design for rolling 3½ in. × 3 in. angles. In this layout the gothic square was entered flat, and required turning the bar over between passes 2 and 3 so that an overfill, formed in pass 2, would be rolled off in the following pass. This pass design, though not one of the best, was in use at the Union Iron Mills of Pittsburgh in 1878.

Drawing 3 shows another old design. This layout was designed for a three-high mill at Passaic, N. J. and was in use in 1898.

In the design just shown, the ends of the legs were filled out very irregularly in the rolls and the passes necessarily were kept underfilled to avoid the fins which might occur were the passes completely filled and which, if formed, would develop into undesirable laps. Due to this underfilling of the passes, which precluded any edge work on the legs, there was considerable cracking at the ends of the legs because the angles were rolled from iron piles, the stock used in the early days.

These difficulties in the rolling of angles led to the first attempts to flare the angle legs out so that the roll collars could be alternated up and down.

Just when and where these first leg bending schemes were tried is not definitely known, but in a U. S. Patent granted to Alexander Swift and James E. York of Newport, Ky. in the year 1875 the bending of the legs is shown. While the inventors stated that the flaring out of the legs had already been proposed, their patent produced a thickening of a portion of the angle legs in the passes on the radius and near the end of the legs



Drawing 1 — This early English rolling mill was built by Henry Cort at Wortley, England.

and left a preponderance of metal at this point. The result was an excess draft to counteract the tendency for leg cracks in the iron. (Drawing 4.)

In 1881 an angle design was patented by J. L. Lewis, which also showed the butterfly design. In this design, however, the inventor claimed to roll three angle sizes in a two-high set of rolls. A glance at Drawing 5 shows how this was accomplished. Passes 1–2–3–4–5 and 6 produced the angle shown in Figure 1. The smaller angle shown in Figure 2 was produced by using the first pass and then edging the bar in pass A to a smaller overall size. This was followed by passes 2–3–4–5 and 6. The angle shown in Figure 3 was produced by using pass 1 as before, then edging in A and B, and finishing as before in passes 2–3–4–5 and 6.

In the angles produced in Figures 2 and 3 it may be noted that the legs do not fill the pass out to the collars. The inventor stated that this feature did not interfere with the making of a good angle section.

The butterfly layout for rolling angles has now become the almost universally adopted design, and an examination into the best forms of this type should be interesting to the student of roll design. The butterfly principle may be applied in many ways, and the following pass layouts will serve to illustrate the various types of butterfly angle pass designs with an explanation for their use.

ANGULARITY OF ANGLE PASSES

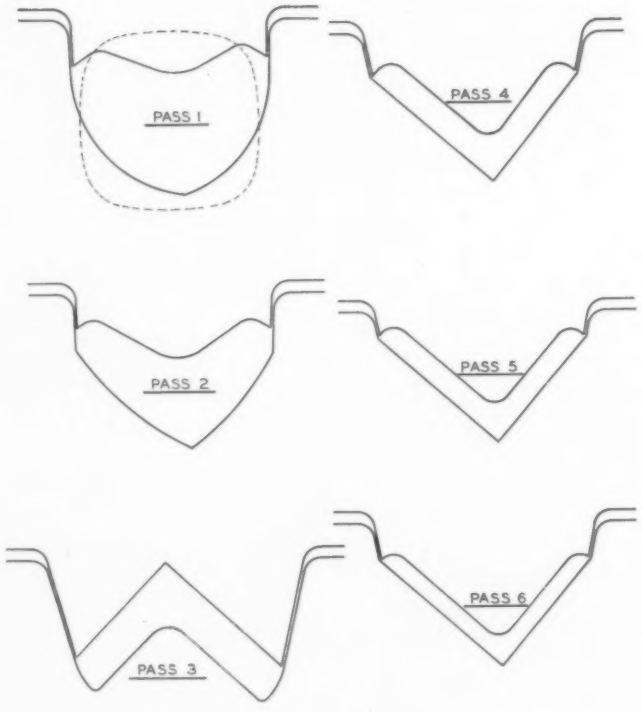
The finishing pass where the angle takes its final form and where the butterfly leader is bent into the 90 degree angle has two general designs. In one of these the pass has no ends or "stops" (Figure 1, Drawing 6) and in the other pass form, stops are used, (Figure 2, Drawing 6).

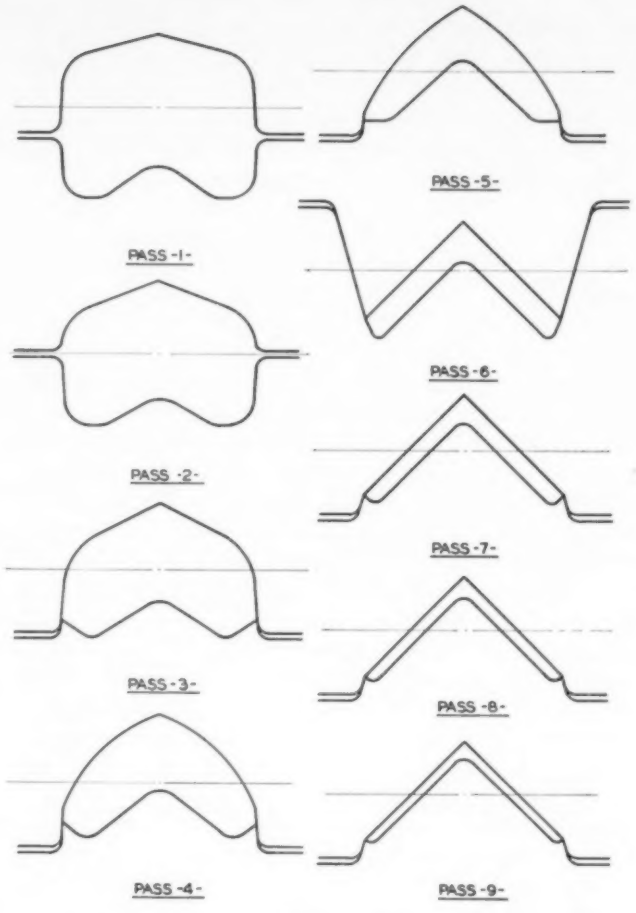
In the thinner sections of angles there is no particular merit in the stop other than to roll a radius on the angle leg. Some rolling mills do not use stops on the finishing pass, and where stops are not used there is no definite radius on the ends of the angle legs.

In the thicker sections of angles there is a definite advantage in the use of stops on the finishing pass, not only to fix the radius but also to roll the angle leg against the stop in order to square the ends and to produce a good finish on them. Thick leg angles rolled in a finishing pass without stops are often irregular in leg length and the ends of the legs are off square and may have a rough surface. When stops are used the finishing rolls require a rather long roll body length in order to provide space for the several finishing passes needed for the various angle leg thicknesses. Those mills having short roll bodies for the finishing stand can provide only one finishing pass for even angles and one other for all uneven angles.

In the one design a set of angle finishing rolls with

Drawing 2 — Drawing shows a 3½ x 3-in. angle rolled at the Union Iron Mill in Pittsburgh in 1878.





Drawing 3 — The 6 x 6 in. angle shown was rolled at Passaic, N. J. in 1898.

two passes will roll all angle sizes using one pass for even leg angles and another one for uneven leg angles. In the design with stops one set of finishing rolls is required for each angle section. In the case of the single set of angle finishing rolls being used for all sections, the roll cost is naturally much less than where several sets of rolls are necessary. The mill with adequate finishing rolls, however, will produce the best looking sections.

The advantages of the butterfly design in rolling angles can be shown by a comparison of this design with that where there is no flaring out of the angle legs.

In each angle size it is necessary to roll several leg thicknesses, and unless each leg thickness has an individual line of passes the leg lengths of the various thicknesses cannot be produced accurately.

The rolling of more than one leg thickness in a line of roll grooves means, of course, that the pass drafts designed to produce the one leg thickness must be changed when other leg thicknesses are rolled in these grooves. The effect of this increase or decrease may be seen by observing Figure 1 of Drawing 7, (a 4 × 4 in. angle). Assuming that the finishing roll pass has stops, as shown on the bottom roll, the distance "A" is fixed in the roll, and any increasing of the leg thickness by raising the top roll does not change the "A" dimension, but does increase the leg thickness and overall leg length. Rolling a $\frac{1}{8}$ in. thicker leg in the same pass means that the "A" dimension should be $3\frac{1}{4}$ in., but as it is fixed in the groove, it remains at $3\frac{3}{8}$ in. This means that only one leg length can be produced accurately in a finishing pass of this kind.

Figure 2 of Drawing 7 illustrates one of the older straight leg leader designs and shows that raising the top roll on this pass to increase the leg thickness $\frac{1}{8}$ in. also increases the leader length by the same amount.

Figure 3 of Drawing 7 shows the first shaped pass of this straight leg design, and here again raising the top roll increases the leg length the same amount as the leader and finishing passes.

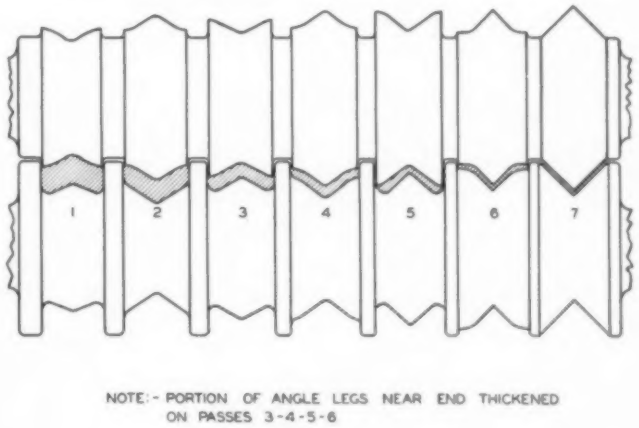
Figure 4 of Drawing 7 shows a butterfly leader design. Raising the top roll $\frac{1}{8}$ in. for a thicker leg lengthens the leg here $\frac{7}{64}$ in. which is less than in the straight leg design.

Finally, in Figure 5 of this drawing, it is shown that in the first pass of the butterfly design, raising of the top roll increases the leg length so little that the leg length in this first pass is practically unchanged. Because of this, it is possible in the butterfly design to roll to closer leg tolerances than in the straight leg angle design. This is one of several advantages of the butterfly design.

Drawing 8 shows one of the old 4 in. × 4 in. straight leg angle designs as used in 1887 to roll iron angles. This design is somewhat similar to the uneven angle which was shown in Drawing 2. Pass 4 is for an $\frac{11}{16}$ in. leg thickness, and the $\frac{1}{2}$ in. leg thickness is produced in pass 5 by using the $\frac{11}{16}$ in. pass as a leader. The $\frac{3}{8}$ in. leg is rolled by using the $\frac{1}{2}$ in. pass as a leader. Since the roll opening of passes 4, 5 and 6 are at the same part of the grooves, it follows that any overfill developed in pass 4 will continue in passes 5 and 6. Since this is objectionable, passes 4 and 5 must be left underfilled when bars are to be finished in passes 5 and 6. This sort of condition does not permit the rolling of the bar against the stops, and consequently, the ends of the angles in this sort of design are not square.

Drawing 9 illustrates a six pass butterfly angle design for 4 × 4 × $\frac{5}{16}$ in. angles with the passes distributed among several sets of rolls, and this layout permits a good rolling action. The fact that the first two passes of the series do not increase the leg length appreciably when raised to produce the thicker sizes, permits the designer to arrange a line of passes to follow the first two so that a $\frac{5}{16}$ in. leg, a $\frac{7}{16}$ in. leg, and a $\frac{9}{16}$ in. leg may be produced to accurate lengths with a definite radius on the leg end. The $\frac{3}{8}$ in., $\frac{1}{2}$ in., and $\frac{5}{8}$ in. sizes are

Drawing 4 — The Swift York method for rolling angles is illustrated in this figure.



rolled only slightly longer than the 5/16 in., 7/16 in., and 9/16 in. sizes.

Other advantages of the butterfly system become very apparent when comparing the first passes of the butterfly system with some of the other types of first-forming passes for angles.

One of the early straight leg schemes used in Europe is that shown in Figure 1 of Drawing 10, and is an early Austrian design. In this the billet enters the first pass diagonally.

Figure 2 of Drawing 10 shows an uneven leg Austrian angle design. The first pass of this scheme takes a gothic billet. A characteristic of this type pass is that the entering stock will not enter flat but will turn in the pass, as shown by the dotted lines, and the pass will be underfilled at A and A1 and overfilled at B.

Drawing 11, Figure 1, explains how this rolling action takes place. This illustrates a type of pass which is used for a special design of angle and is somewhat similar in shape to the first pass of the Austrian angle design. The drawing shows five successive steps in the formation of the billet being rolled into the pass. The sketch marked "A" of Figure 1 shows how the rolls first bite into the stock. Note that the largest bite is taken on the top and this immediately tends to cause the billet to assume an angular position in entering. In the second stage, as shown in "B" of Figure 1, Drawing 11, the bottom roll engages the billet fully across the bottom while the top roll is engaged on slightly more than half. This action has a tendency to further turn the billet. Since the roll collar on the left side is almost straight, there is only a small reduction on the side, and the collar holds the billet from going any further to the left. In the third and fourth position, the same relative action takes place and the entering piece is twisted still more. The final section out of the rolls shows the pass underfilled on the upper projection and filled out on the sides in a manner which indicates the angled position the entering billet has taken.

These successive cross-sections show that the major part of the reduction is accomplished on the right-hand side of the billet, the left-hand side receiving very little rolling action. The effect of this one sided reduction is not only to cause the billet to twist due to the bottom roll pushing the left side of the billet up, but also the draft induces extra spread on the right-hand side. Due to the small amount of reduction on the left, there is little elongation of this part. Since there is a considerable reduction of the right-hand part, the tendency is for a corresponding elongation in this area. The left-hand side not being elongated holds that side back except as it is stretched by the elongation of the right-hand part. These opposing forces resist each other, and as the right-hand side must either elongate or spread the result is an abnormal spread while the left side is stretched to a certain extent. Ordinarily a billet of this size would spread approximately 1/4 of the total amount of reduction or 0.25 in. per inch. In the figures shown the spread is nearly twice normal or approximately 0.45 in. per inch of reduction.

Had the pass been made a tight fit sideways in the endeavor to hold the billet straight, some correction of this twisting action would have been possible, but there would be a long, heavy overfill at the roll parting on the right side.

Since it is practically impossible to completely fill

Drawing 5 — The butterfly method for rolling angles which was designed by J. L. Lewis could roll three different angle sizes in a two high set of rolls.

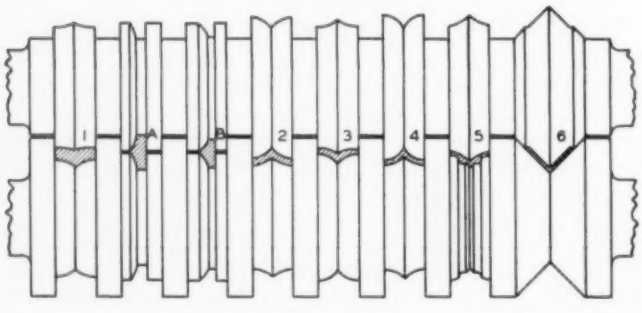


FIGURE -1-
PASSES USED ARE 1-2-3-4-5 & 6 FOR ABOVE ANGLE

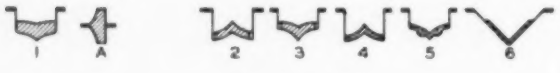


FIGURE -2-
PASSES USED FOR ABOVE ANGLE. NOTE EDGING PASS A IS USED

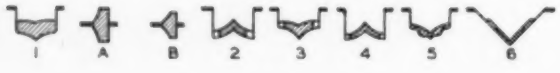


FIGURE -3-
PASSES USED FOR ABOVE ANGLE. NOTE EDGING PASSES A & C ARE USED

Drawing 6 — The two figures show finishing angle passes with and without stops.

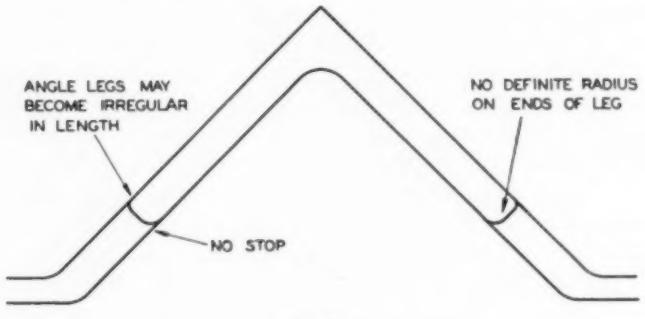


FIGURE -1-

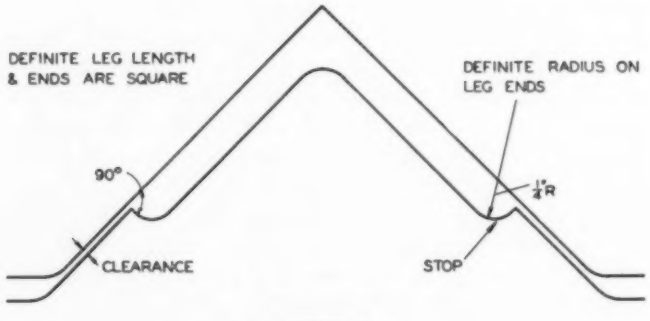
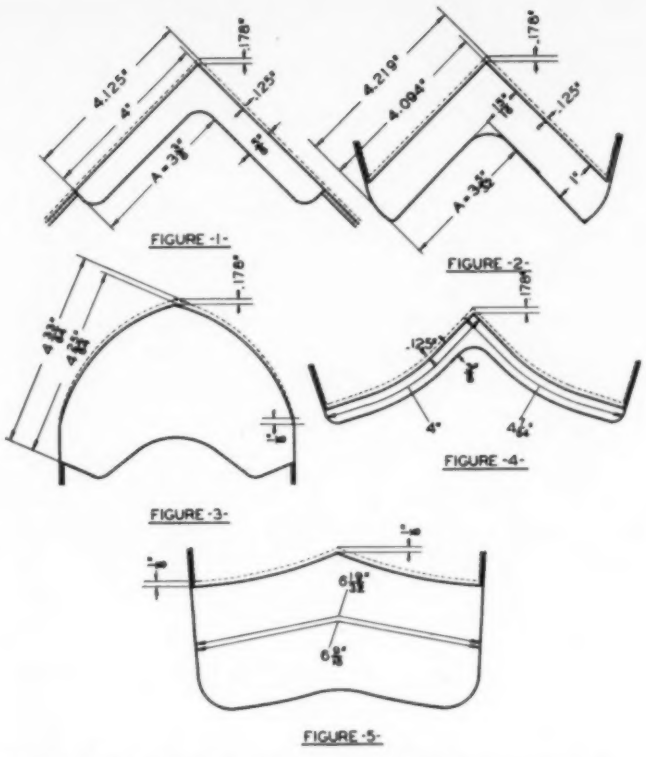
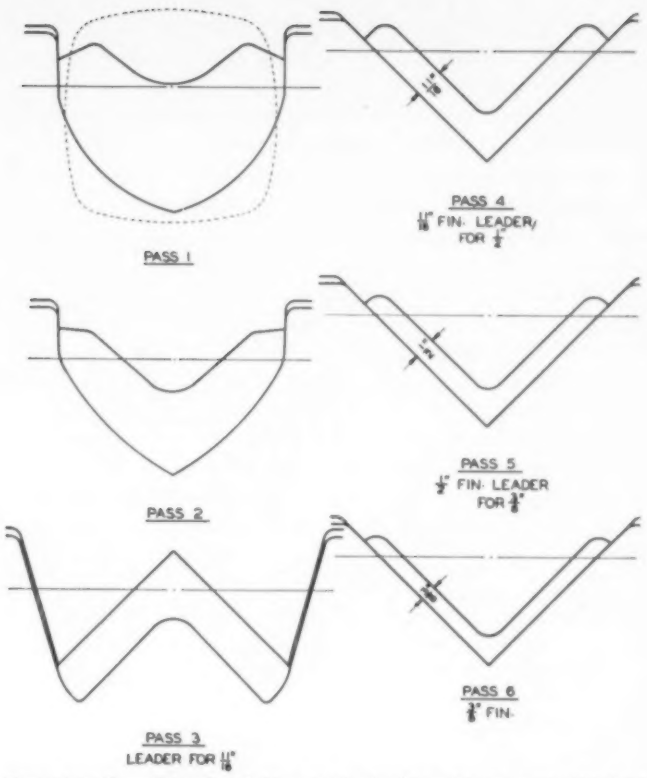


FIGURE -2-



Drawing 7 — The effect of raising rolls to increase the flange length is given by the sketches.



Drawing 8 — The 4 x 4-in. angle design shown was used as early as 1887.

the top left side of the groove, this type of pass is not as efficient as the one shown in Figure 2 of Drawing 11. In this design the same size pass is put in the rolls at a 45 degree angle, and the figures "A," "B," "C," and "D" show the successive steps as the bar is engaged in the rolls. Note that there is some tendency of the billet to twist when entering, but that it is small. The angle of the left-hand collar permits some work on that side of the billet. The bottom roll reductions tend to twist the piece to the right while the top roll reductions are greater on the left side of the center line than on the right. This corrects some of the twisting action and tends to push the metal toward the upper left corner with the net result being that the left side of the pass is filled and the right side spreads as shown. The spread, however, is less than in the previous example.

In the butterfly design, as has been shown, the first pass is nearly flat in shape, the entering stock has no tendency to twist, and the reduction is uniform on both legs. The fact that the pass is easily filled is another advantage of the butterfly design.

SHAPE OF LEADER PASS

In the straight design for angles, the leader pass, as illustrated in Figure 1 of Drawing 12, is formed so nearly like the finishing pass that there is little danger of the entering bar being deflected out of its proper course through the finishing pass. The entering side guides merely assure correct entry and need not fit too closely. Figure 2 of the drawing shows a leader pass which also has little tendency to move out of its proper course through the finishing pass. Figure 3 shows a leader pass more extreme in the flaring out of the legs, and with this type of leader, a great deal of care must be exercised with the entering side guides to hold the apex of the leader in accurate alinement with the apex of the finishing pass. If this alinement is not correct, the lengths of the angle legs will vary, and the apex of the angle will be underfilled and not 90 degrees and sharp. Figures 3A and 3B show the underfilled condition of the apex referred to.

This chamfered condition of the apex of an angle, erroneously called "round back," is more prevalent in uneven angles than in even angles. On even angles the steering of the leader bar into the finishing rolls is comparatively easy, since there is no good reason for unequal leg length or thickness. On uneven angles the problem is more complex. An uneven angle leader must be held more exactly in position while entering the finishing pass than an even angle. One of the reasons for this is the uneven spring of the rolls on the legs of the uneven angle. On a 6 × 4 in. angle, the 6-in. leg has 50 per cent more surface in contact with the rolls than the 4 in. leg. The roll pressure, then, on the long leg is stronger than on the short leg and this causes greater roll spring on that side. The long leg of the angle, therefore, will become thicker than the short side unless, of course, the rolls are set to counteract this effect. An uneven angle leader pass which has a thicker long leg will have a tendency to cause the long leg apex to ride toward the short side causing an underfilled condition on the long leg apex. Should the short side be greater in thickness, the effect will be the opposite. This phenomenon is due to unequal elongation between the two legs, assuming that the angle is being guided into the finishing pass correctly. The draft being greater on the long leg, that part elongates more than the short leg, and also enters more slowly than the short leg side causing the

entering bar to push toward the short leg side. If the bar is held tightly in a straight line by guides and table guards to prevent this movement, a buckling or heaving action will take place causing the entering bar to roll and thrust toward the short side while also pushing the leader apex toward the short side.

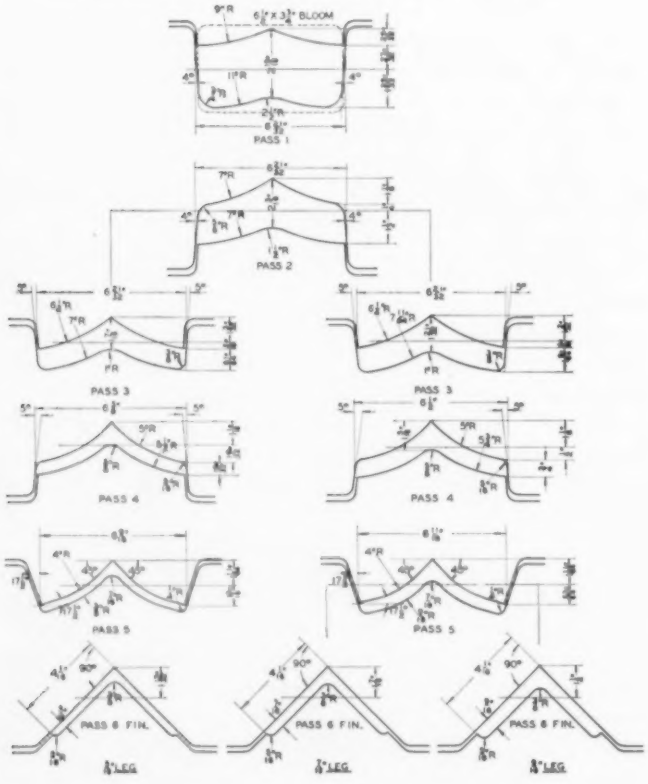
Figures 4 and 4A show a type of leader pass in which the legs are flared out but without any curvature. In this design, the shape is such that it is extremely difficult to keep the leader bar in alinement with the finishing pass due to the ends of the legs having to make a long bend to enter the finishing pass. In addition to the shifting sideways, a seesawing over the inside corner radius of the finishing pass is prevalent and adds to the difficulties.

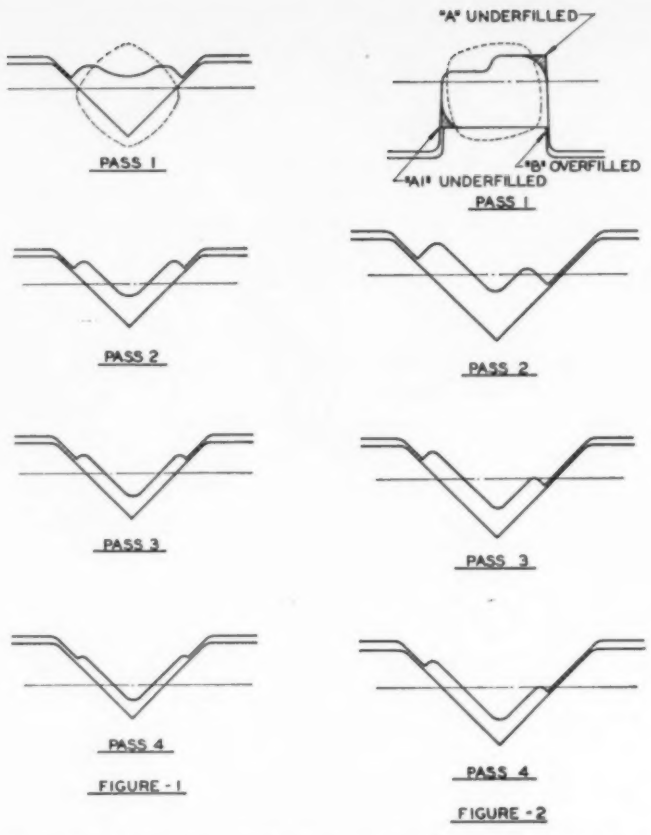
Figure 5 illustrates a leader pass design seldom seen in modern practice but used to a limited extent in past years. The difficulties of the design shown in Figures 4 and 4A are to be found in still a greater degree in this design.

While it can be seen that the straight or nearly straight leader design shown in Figures 1 and 2 of Drawing 12 will enter the finishing pass with the least amount of deviation, the advantages of flaring out the leader legs, as they are in the butterfly design, are so great that it has become the favored design.

In Figure 6 of Drawing 12 is shown a leader pass design for even angles, and in Figure 6A one for uneven angles, both of which illustrate designs that are not too extreme in the flaring out of the legs. They fit the finishing pass well in the apex part, and do not have to be bent too far in entering the finishing pass. This design gives all the advantages of the butterfly system and few of its disadvantages.

Drawing 9 — Drawing shows a six pass butterfly angle design for rolling 4 x 4-in. angles.





Drawing 10 — Even and uneven angles were rolled as shown in Austria in 1906.

Figure 1 of Drawing 13 illustrates a leader pass design which fits the finishing pass well in the apex, but has one disadvantage; the legs are flared out parallel to the axis of the rolls and the sketch shows the effect of thickening the leader for heavier weights. Note that the part which is at a 45 degree angle must be raised 0.125 in. to produce a $\frac{1}{8}$-in. thicker leg. The part which is parallel to the roll axis then becomes 0.177 in. thicker. This gives an increased reduction in the finishing pass on the ends of the legs over the part forming the apex and the heavier draft causes extra spread on the ends of the legs and lengthens the overall leg size excessively. In uneven angles there is another disadvantage. This is illustrated by Figure 2. The long leg must be bent through a larger arc than the short leg, and the effect of this is longer leverage inducing the apex of the leader to be pulled toward the long leg thus tending to cause an underfilling of the apex on the short leg side.

In Figure 3 which illustrates an angle leader similar to that shown in Figure 6 of Drawing 12, it will be seen that in thickening the angle legs $\frac{1}{8}$ in. near the apex, the leg ends are thickened to only 0.169 in., and with this smaller draft on the ends there is less spread of the legs than in the example shown in Figures 1 and 2. Also, the long legs of Figure 4 are bent into the finishing pass in a smaller arc than the leader shown in Figure 2, and with less shifting of the leader apex in entering the finishing pass.

In the leader pass it is vitally necessary for the entering bar to roll firmly against the end collars of the roll so that the leg ends will be square and uniform in length throughout the bar. If this is not done, the tendency will be for the angles to be uneven in the leg

length on the front, middle, and back ends of the bar.

ANGLE OF FINISHING PASSES FOR UNEVEN ANGLES

Even angle finishing passes are set in the finishing rolls with the legs 45 degrees from each side of the center line of the pass as illustrated in Figure 1 of Drawing 14. In the rolling of uneven angles there are several problems encountered that are not found in even angles and one of these is in setting the angle of the finishing pass.

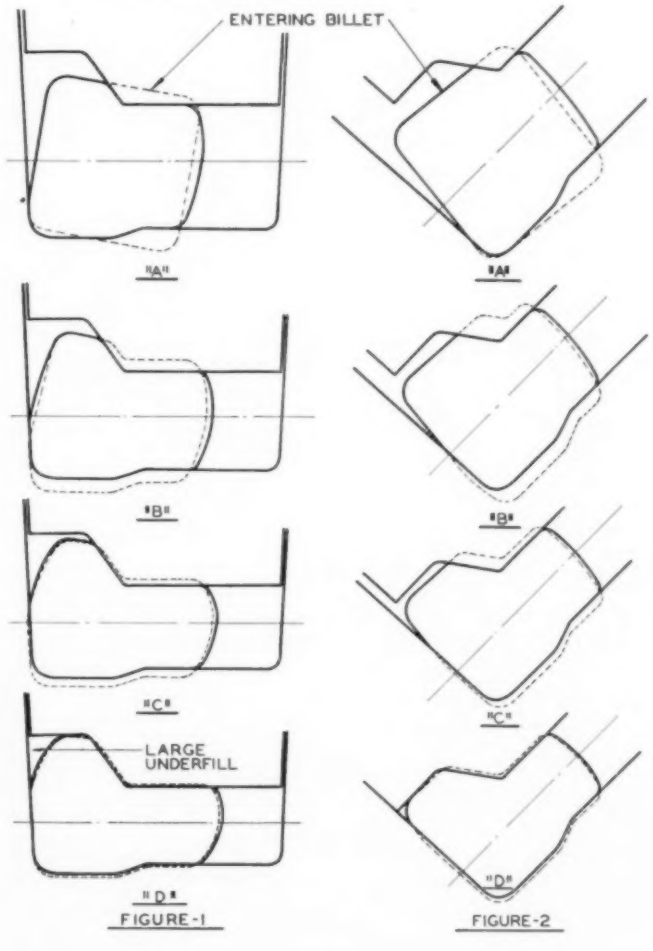
Figure 2 of Drawing 14 shows a 9 × 4-in. angle set in 28-in. diameter finishing rolls with 45 degree angles on each leg. With this setting, there are some greatly differing roll diameters on the various parts of the bar; for example, diameters A and B. A is the largest diameter on the pass and B is the smallest, and both work on the ends of the long leg. It has been stated that the smallest diameter on a roll groove controls the delivery speed of the bar; that is, the bar cannot leave the rolls faster than the peripheral speed of the smallest diameter, and that on the larger diameter the bar must slip on the roll. This assertion is incorrect, for while the smallest diameters incline to hold the bar down to their peripheral speed, the larger diameters send the bar forward, and there is slippage at both the large and small diameters, as can readily be observed by examining the roll surfaces of worn rolls and noting the greater wear on the largest and smallest diameters of angles and zee bars as compared to the wear of the average diameters.

Where a large diameter on one roll is opposite a correspondingly small diameter on an opposing roll as noted in Figure 2 of Drawing 14, an undesirable twisting action is developed in the delivery of the bar. The roll is small and weak also at the diameter marked H, and the finishing passes must be placed further apart in the space available with this arrangement.

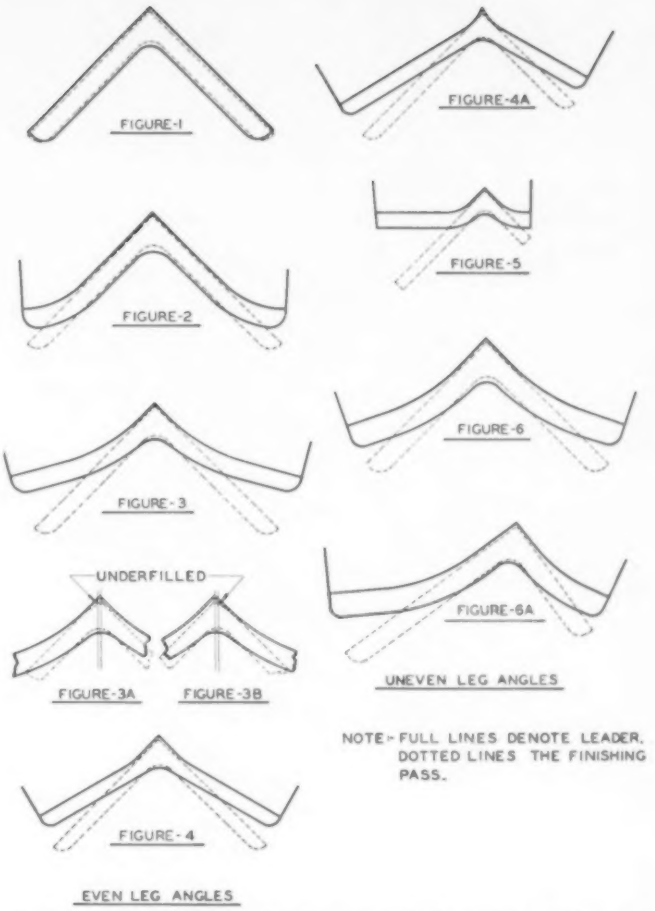
For these reasons, it is customary to set uneven angle finishing passes as shown in Figure 3 of Drawing 14. With this arrangement the roll diameters of the 8 × 4-in. angle in the figure shown may be made even or nearly even, and there is much less difference between the top and bottom roll diameter and most of the twisting action is eliminated.

This arrangement shown is fairly satisfactory for angles up to 8 × 4 in. but in larger angles another difficulty appears.

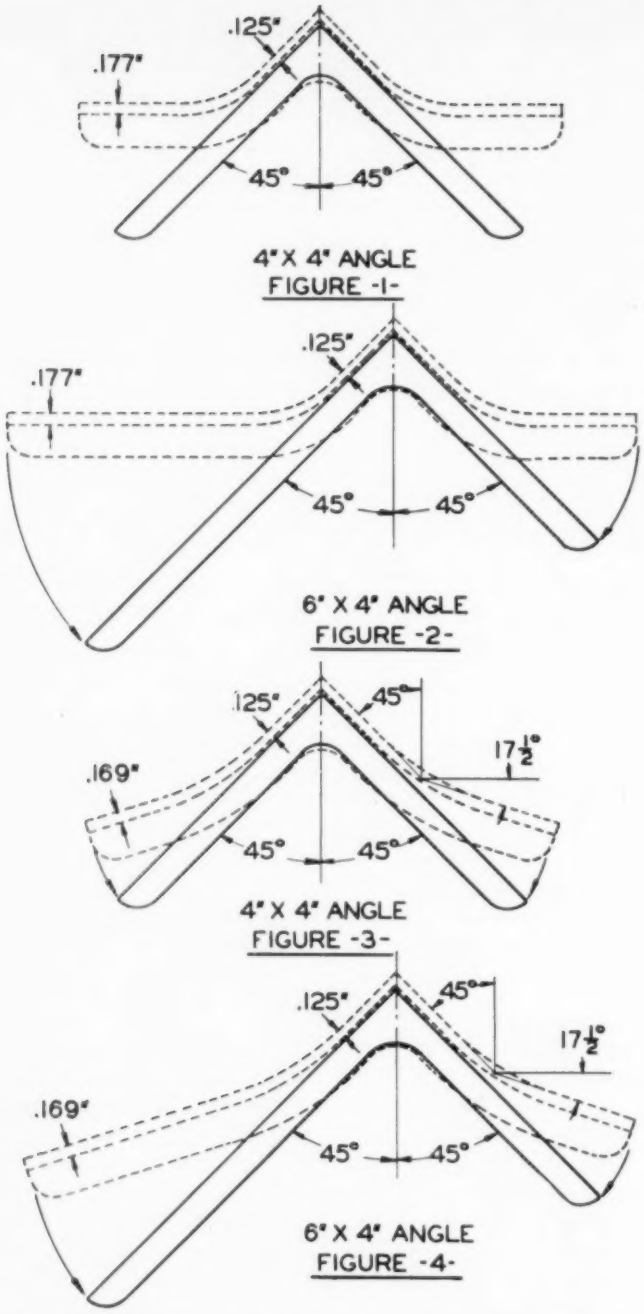
Figure 4 of Drawing 14 illustrates a 9 × 4-in. angle finishing pass. The finishing pass in dotted lines show the bottom of the leg ends with equal diameters. This gives an angle for the short leg of 22 degrees. It will be noted that the leader (also in dotted lines) has the short leg extending over the top roll collar at A. In bending the leg into the finishing groove, this collar will rub on the leader leg and in many cases cause shearing of the leg at this point.



Drawing 11 — Drawing shows the various contact points of roll pass on entering billet.



Drawing 12 — Various leader pass designs for angles are given in these figures.



Drawing 13 — Effect of raising leader pass for greater leg thickness.

The full lines show the finishing pass set with the short leg at 27 degrees, and with this arrangement the leader leg is sufficiently into the corner radius, as shown at B, so that there is no rubbing at the roll collars and no shearing, and the roll diameters are not too uneven.

Drawing 15 illustrates a pass design for 8 × 6-in. angles with the ends of the legs at even diameters. In this layout the short leg of the finishing pass has an angle of 36 degrees which presents no difficulties in bending the short leader leg into the finishing groove.

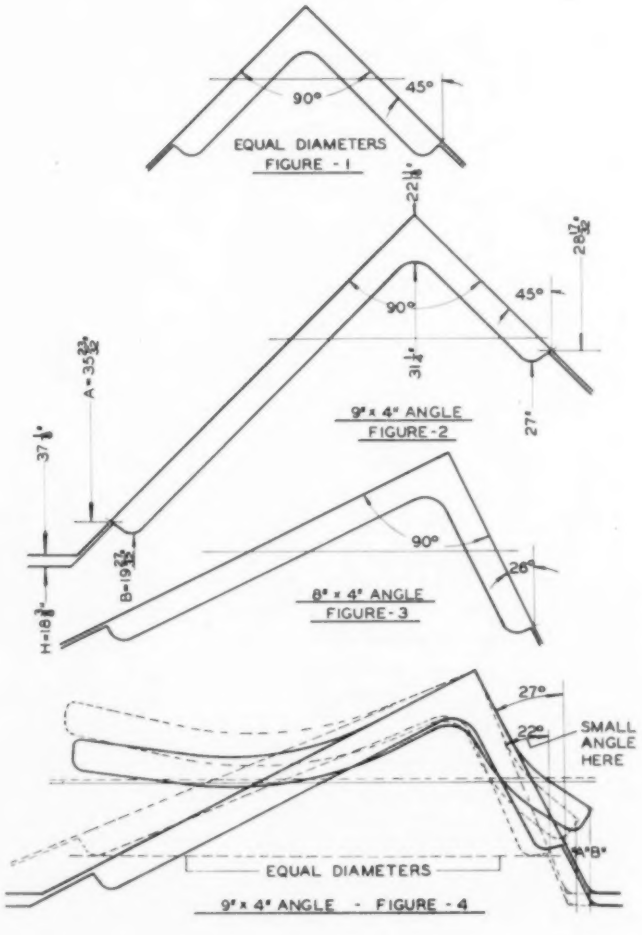
SMALL ANGLES

In the designs discussed so far the angles have had all tongue and groove passes. Angles in the smaller sizes as rolled on bar mills are sometimes designed so that there are no tongue and groove passes in the first formations. Drawing 16 illustrates one of these designs, a $\frac{7}{8} \times \frac{7}{8} \times \frac{1}{8}$-in. angle as rolled in six passes. The first and second passes of the design are turned with a groove in plain slabbing rolls and this groove produces a projection on the top of the bar which gives extra metal to form the apex of the angle. In a design of this kind, the entering stock must be held firmly in position so that the apex portion will be in the desired place. Since there are no sides to these two passes, the bar will spread more or less irregularly making it difficult to maintain a constant width of bar. Pass 3, an edging pass, is designed to edge the bar and regulate its overall width so that it will properly fill pass 4, a tongue and groove pass. Pass 5, the leader, is a tongue and groove pass and pass 6 is the conventional 90 degree angle finishing pass without stops.

This design is popular because the first three passes may be used for several angle sizes by varying the width of the entering stock and adjusting pass 3 to suit the section rolled.

The straight continuous bar mills which have been built in recent years are well adapted to roll angles. Some of these mills have edging roll stands in combination with a line of horizontal roll stands. This arrangement makes it possible to roll the angles without twisting and features the use of the vertical rolls to edge

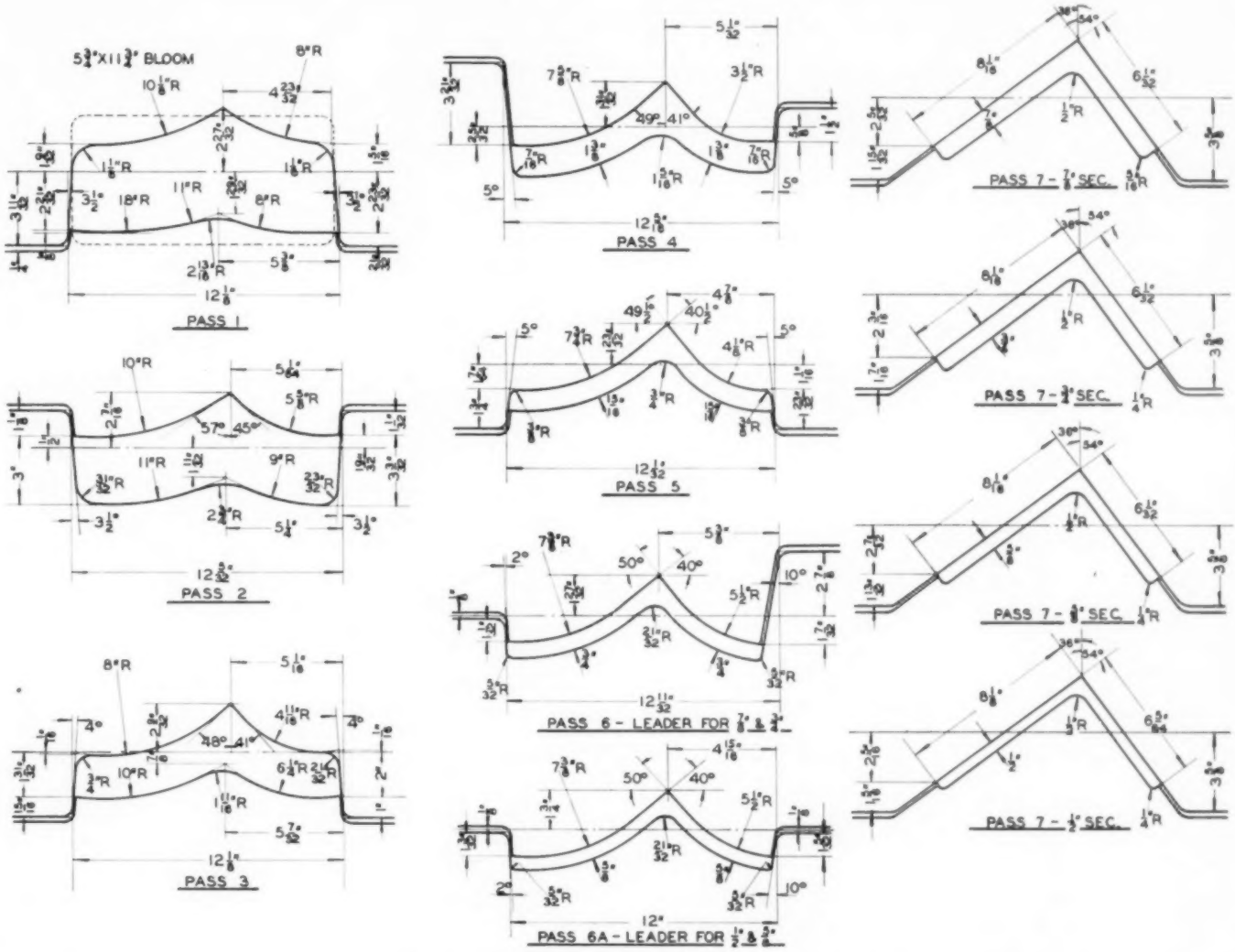
Drawing 14 — Shown here are angle settings for even and uneven angle finishing passes.



the angle legs. Drawing 17 shows an angle as rolled on one of these mills. The first shape pass takes a flat and forms a lump of metal in the center. The next pass, an edging groove, regulates the width and further forms the apex. The next two passes are tongue and groove and following these the next groove bends the butterfly leader produced in the pass into a 90 degree angle. The final pass is also 90 degrees and a very light reduction finishes the angle. The diagram of the mill shows how this pass design is laid out to suit the mill design.

Drawing 18 shows another pass design for a continuous mill with alternate horizontal and vertical stands in the finishing end of the mill. In this layout, pass 6 of the design, an edging groove, takes a flat twisted up into the pass. A bulge is formed at the sides of the pass. Pass 7, in flat rolls, further reduces the bar and provides more metal in the apex. Passes 8 and 9 are tongue and groove passes in the two horizontal stands. Pass 10 is in the first of the vertical roll stands and the groove edges off a small amount of the legs and bends the bar so that the apex is in a higher position. Pass 11 is a tongue and groove pass. Pass 12 is an idle one through the vertical rolls. Pass 13, also a tongue and groove pass, is the leader and the bar is idled through stand 14 and finished in the 15th stand to 90 degree square.

Drawing 19 shows another design of angles as produced on a continuous 14-in. mill. This continuous mill was originally designed to roll angles and flats. The first pass in this design is a flat slabbing pass. The second and third form an apex on the bar, and pass 4, which is a vertical edging stand, edges the bar for width. Passes 5, 6 and 7 further form the angle, bending it slightly in passes 6 and 7. Pass 8 is an edging pass in vertical rolls which further bends and edges the angle. Pass 9 bends the angle still more, and the bar is idled through pass 10 which is a vertical edging stand. Pass 11 is the leader, while pass 12 bends the bar to 90 degrees and finishes it.


PASS 1
PASS 2
PASS 3
PASS 4
PASS 5
PASS 6 - LEADER FOR 7/8" & 3/4"
PASS 6A - LEADER FOR 1/2" & 5/8"
PASS 7 - 7/8" SEC.
PASS 7 - 3/4" SEC.
PASS 7 - 5/8" SEC.
PASS 7 - 1/2" SEC.

Drawing 15 — Drawing shows passes for 8 x 6-in. angle with ½, ⅝, ¾ and ⅞ in. sections.

Many small angle sections are rolled on hand bar mills. One of these, a ¾ × ¾ × ⅛-in. angle, is illustrated in Drawing 20. This design follows the butterfly pattern. The section is produced in five passes from a ⅞-in. round-cornered square rolled in the roughing of the bar mill.

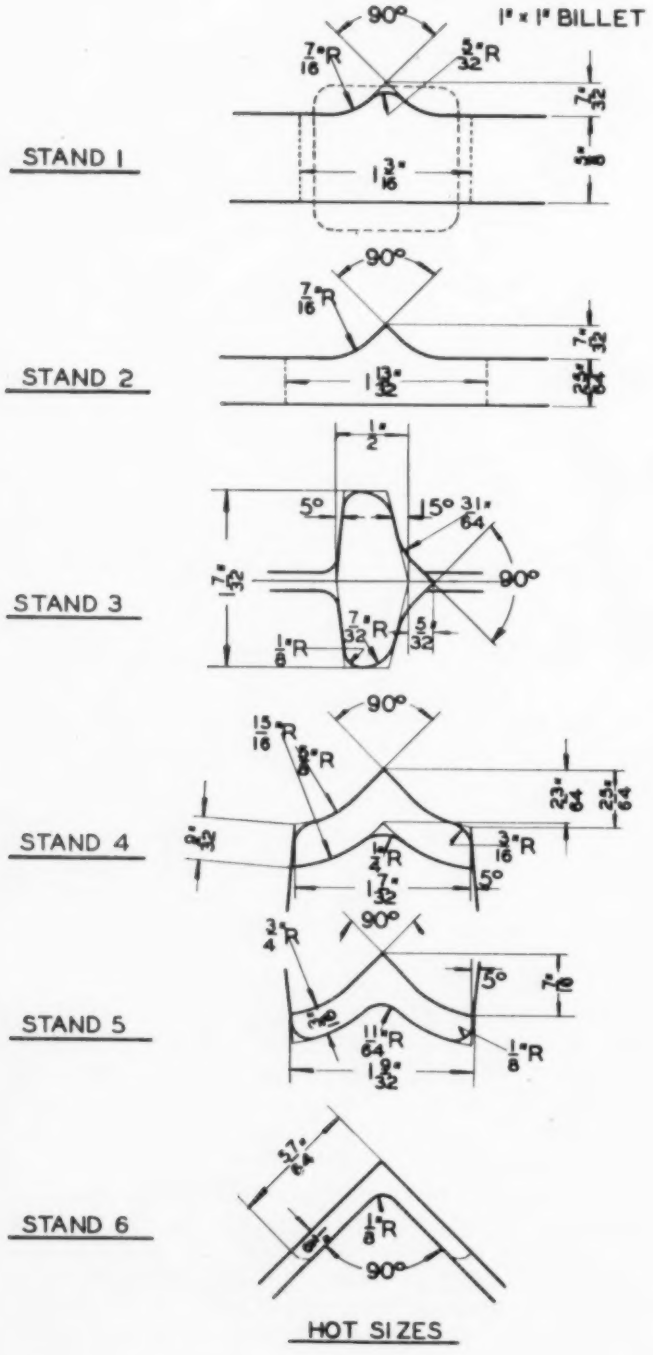
Drawing 21 illustrates another method of rolling the smaller sizes of angles. This design starts with an edging groove where a flat is edged and forced to spread forming bulged sides which in the succeeding pass forms the apex of the angle. This ¾ × ¾ × ⅛-in. angle was rolled on a hand bar mill.

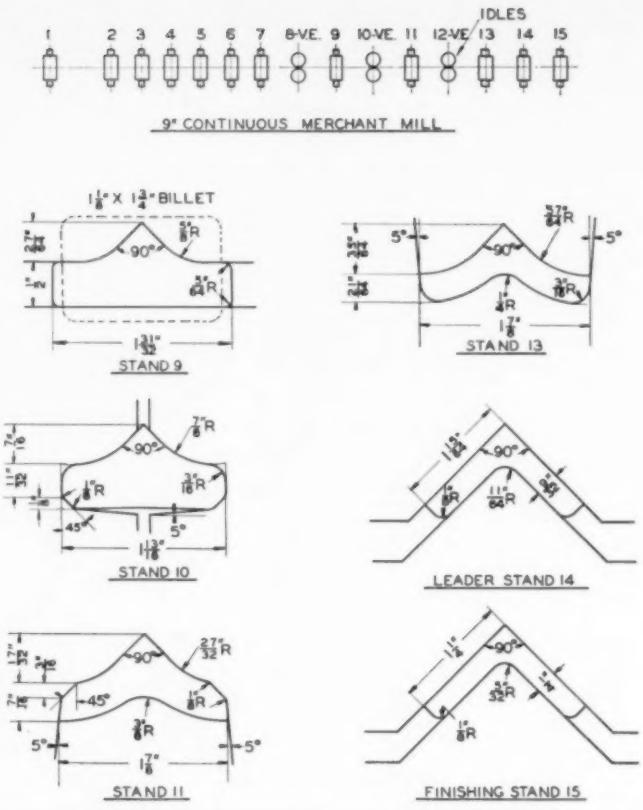
ENGLISH DESIGN FOR SMALL ANGLES

It has generally been thought vitally necessary, when rolling angles without the aid of tongue and groove passes, to start forming the angle apex in the first shaped pass. In Drawing 22 is shown an English design which produces an angle without a starting apex and which forms a square root angle from a plain flat. Pass 1 of the design is an edging groove designed to regulate the bar width. Following this the bar is made convex in a curved pass. The bar is then edged in a groove which causes the bar to be sufficiently thickened in the apex to finish as a square root angle as shown in the drawing.

Among the many angle designs are those used for rolling slit rails. The slitting of rails is said to have been

Drawing 16 — The 7/8 x 7/8 x 1/8-in. angle shown is rolled in 6 passes.




IDLES
1 2 3 4 5 6 7 8-VE. 9 10-VE. 11 12-VE. 13 14 15
9" CONTINUOUS MERCHANT MILL
1 1/8" X 1 3/4" BILLET
STAND 9
STAND 13
STAND 10
LEADER STAND 14
STAND 11
FINISHING STAND 15

Drawing 17 — The drawing shows the passes for 1¼ x 1¼ x ¼-in. angle rolled on a straight continuous bar mill.

first developed by W. Avery Sweet in Syracuse, N. Y., in 1868. In those days, most steel rails were made from bessemer steel. The bessemer works at that time did not use any scrap in the converter and the crop ends from the rail mills were useless. Mr. Sweet saw the piles of crop ends at the bessemer works and rail mill at Troy, N. Y., and conceived the idea of slitting them and rolling the slit pieces into bars. After considerable experimentation, he succeeded in slitting the rails on his bar mill at Syracuse, N. Y., and rolled the head into steel for crow bars, the web into spring steel, and the base into flat bars. The practice spread around the country, and in later years angles were among the sections rolled from the three parts of the rails.

In the slitting mills of the present era, angles are produced from head, web, and base. Drawings 23, 24, 25, and 26 show angle designs using the head, the web, and the base as stock.

Drawing 23 illustrates a slitting pass showing how the rail is slit into three parts and how the head is rolled into a 1¼ × 1¼ × 5/16-in. angle. A 70-lb ASCE worn rail is being slit and rolled in this design. The first pass following the slitting is a tongue and groove design and is not completely filled to the side collars as the pass is made large enough to take a variety of head sizes. The second pass also is not completely filled in the width. The third and fourth passes are used to edge the piece to the proper width for pass 5, the butterfly leader, and the bar is finished in pass 6.

Drawing 24 shows how the web of the 70-lb rail is rolled into a ¾ × ¾ × ⅛-in. angle in 8 passes, the first two of which are used to edge the web down to a size suitable for pass 3, a tongue and groove pass. Passes 4–5–6 and 7 are butterfly grooves and the bar

is finished in pass 8. This size could be rolled easily in two less passes, but the design shown is an example of an early layout.

Drawing 25 shows the base of the 70-lb rail as rolled into a $1\frac{1}{2} \times 1\frac{1}{2} \times \frac{1}{8}$-in. angle in five passes. In this design, the 70-lb rail base is first shortened somewhat by edging in the slitting pass and further edged in pass 1. Passes 2–3–4 are tongue and groove butterfly passes, and the final pass is the conventional angle finishing pass.

Drawing 26 shows another method of reducing a rail head into a $1 \times 1 \times \frac{1}{8}$-in. angle. An oval and square is used to reduce the head into a $1\frac{1}{16}$-in. square. This square is entered diagonally into pass 3 and the bar is further reduced in passes 4–5 and 6.

In rail slitting mills a great deal of ingenuity is used in working the many rail sizes into the required finished forms. The worn out rails are off size, and the designer must provide a number of different ways of working in order to utilize the different rail weights to the most advantage.

BULB ANGLES

Bulb angles differ from standard structural angles in that one leg of the angle has a bulb or projection. In this type of section, the latest practice favors the butterfly design of rolling, and a great deal that has been said about angle design applies equally well to bulb angles.

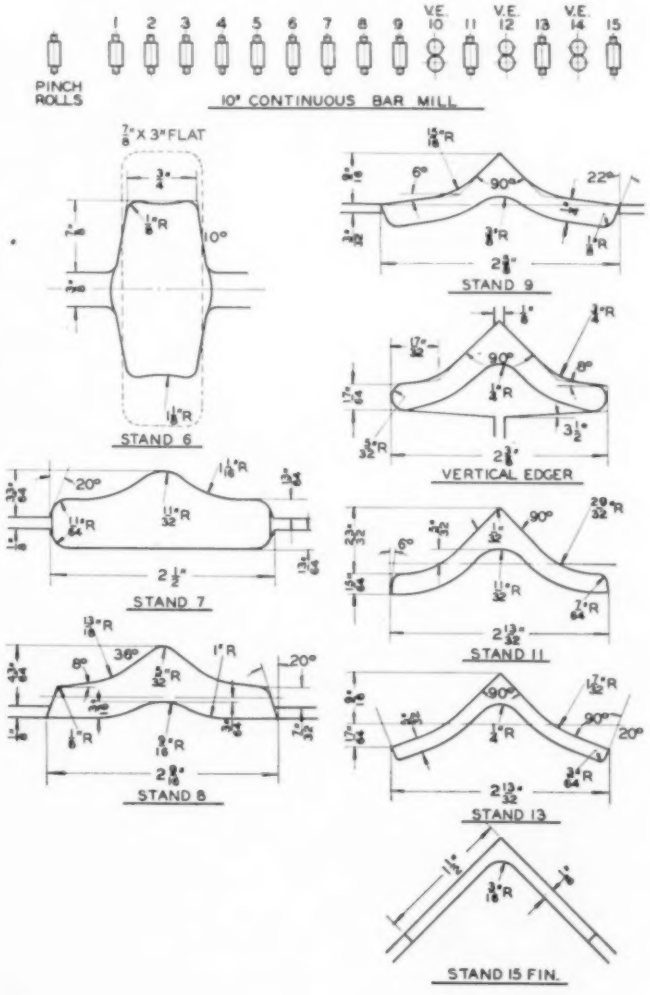
In the finishing rolls, the angle of the pass depends upon the inside taper of the bulb. Drawing 27 shows a $6 \times 3\frac{1}{2}$-in. bulb angle design, and Figure 1 of this drawing illustrates the finishing pass. Note that the inside angle of the bulb, as set in the rolls, controls the angularity of the pass. It is desirable to have the smallest practical angle on the bulb at this point so that the larger angle may be allowed for the short leg. Should the angle of the short leg be small, there is difficulty in bending in the flared out leader leg, just as previously described for uneven angles. The butterfly design of the passes back of the finishing present no difficulty as far as the angularity of the legs is concerned.

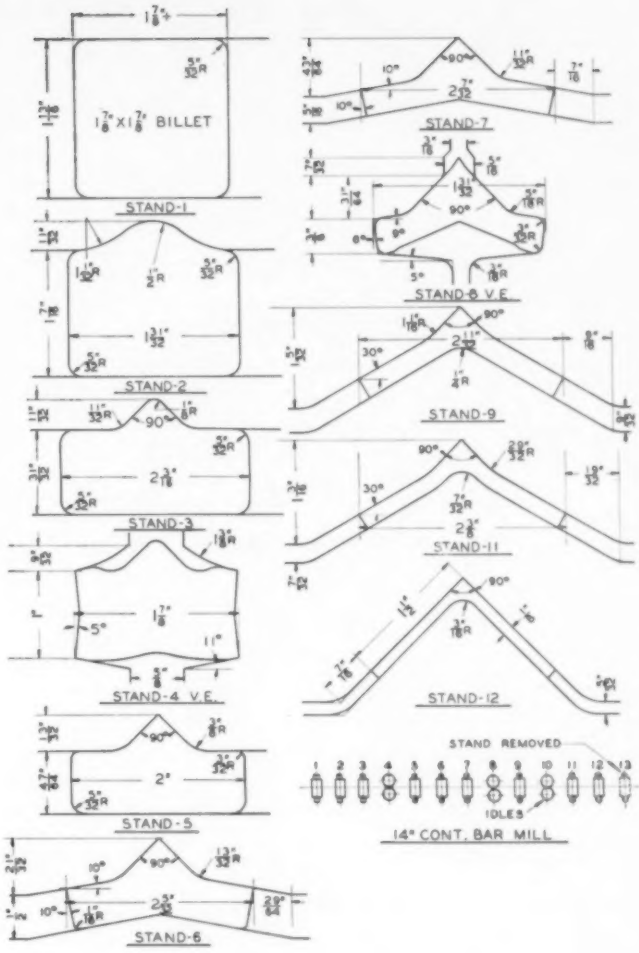
The bulb of the angle being considerably larger in area and thicker than any corresponding size and area of the legs, requires that this part be drafted in an equal ratio of reduction with the legs and this means that the bulb becomes proportionally larger than the legs as it progresses to the first shape pass.

The design calls for a rectangular bloom to be used as stock, and the problem is to force this rectangular bloom to fill the bulb side of the first pass, although the initial draft is lighter here than that on the middle and left side of the pass.

Should the first pass of the design be set in the rolls

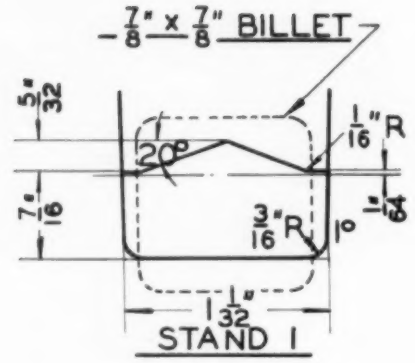
Drawing 18 — The continuous mill illustrated in this drawing has some alternate vertical and horizontal stands. Design shown is for $1\frac{1}{2} \times 1\frac{1}{2} \times \frac{1}{8}$-in. angle.

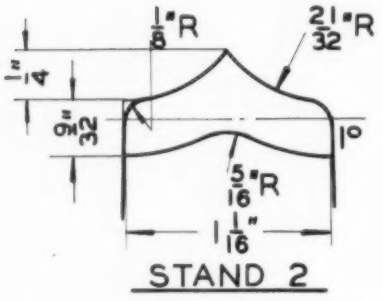


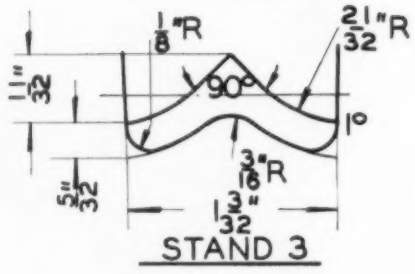


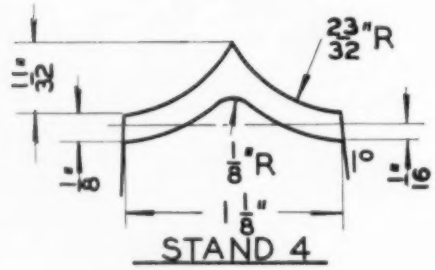
Drawing 19 — Passes for $1\frac{1}{2} \times 1\frac{1}{2} \times \frac{1}{8}$-in. angle.

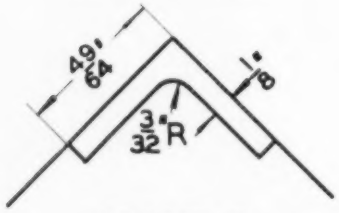
5 - STAND BAR MILL











HOT SIZES

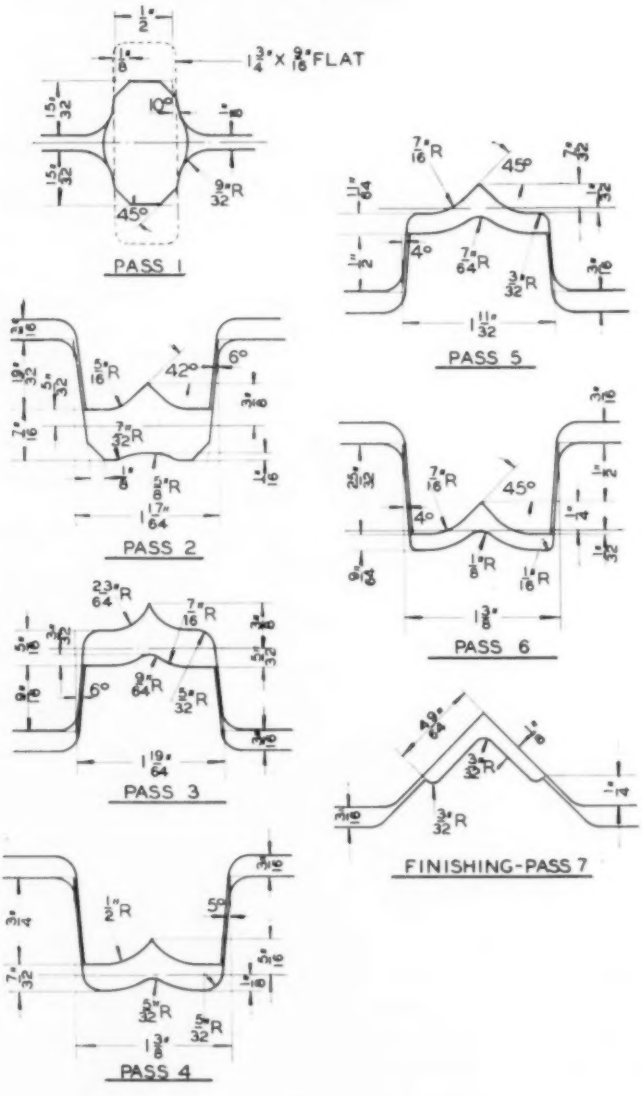
Drawing 20 — Passes for 3/4 x 3/8 x 1/8-in. angle.

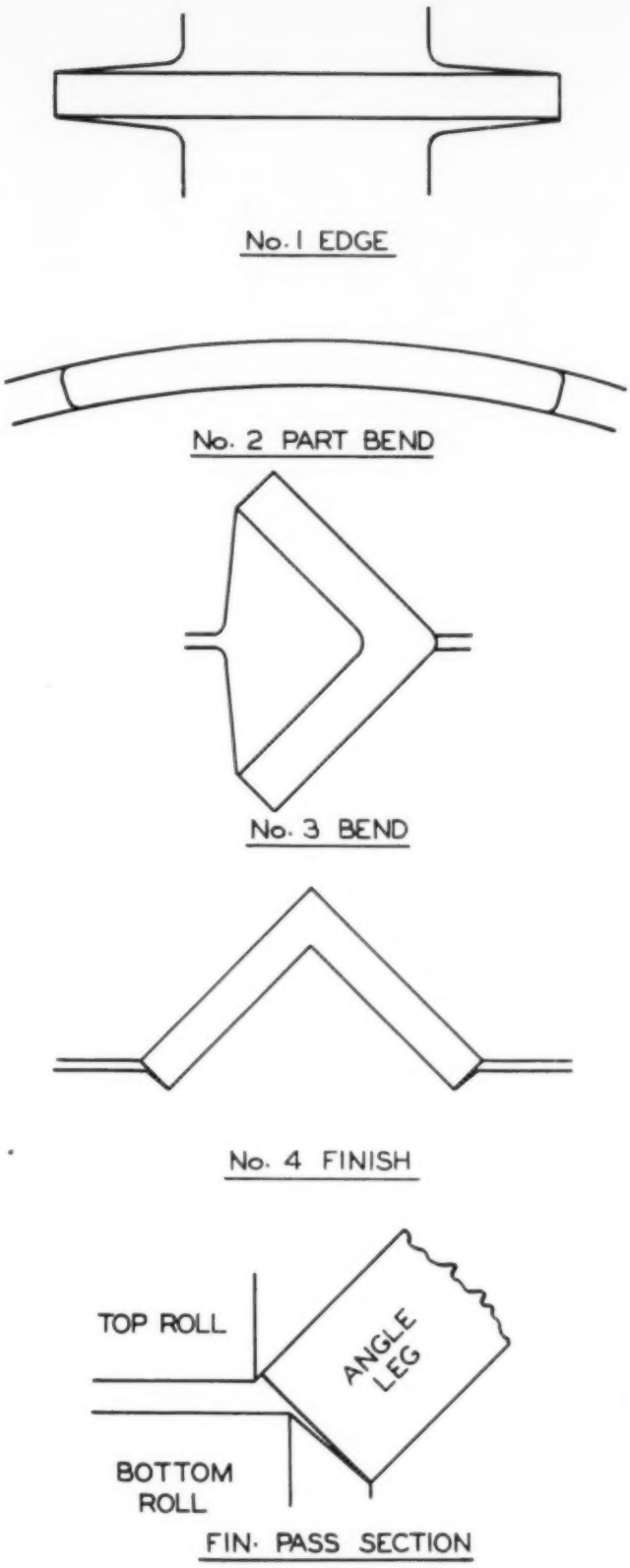
at the angle as shown in Figure 2 of the drawing, the tendency will be for the bulb side to be underfilled as the heavy reduction on the middle and left side will tend to fill that side, and the elongation of that side which is greater than that of the right side will draw the metal of the right side away, and that side will be somewhat underfilled. Although the bulb side may be somewhat underfilled there is enough metal to produce the finished section.

In Figure 3 is shown a better design for the first shape pass and one which will adequately fill the bulb side of the first pass using the same size bloom as in Figure 2. In this layout the pass is tilted to the right, and the bulb side made larger in area than in the pass shown in Figure 2. Angling the pass in this way causes the billet to be pushed by the roll collars to the right side, and although that side is larger than the groove shown in Figure 2, it will be filled properly and thus furnish more stock in this part for the succeeding passes. This rolling action is similar to that which we described earlier in connection with angles.

Drawing 28 shows another design for a 5 in. × 4½ in. bulb angle. Figure 1 of the drawing shows the finishing pass. Note the small angle of the left leg. The inside

Drawing 21 — Passes for a 3/4 x 3/4 x 1/8-in. angle on a hand bar mill.





Drawing 22 — The drawing shows an English design for a 1½ x 1½ x ¼-in. angle.

angle of the bulb being small makes it necessary to set the pass at the angles shown.

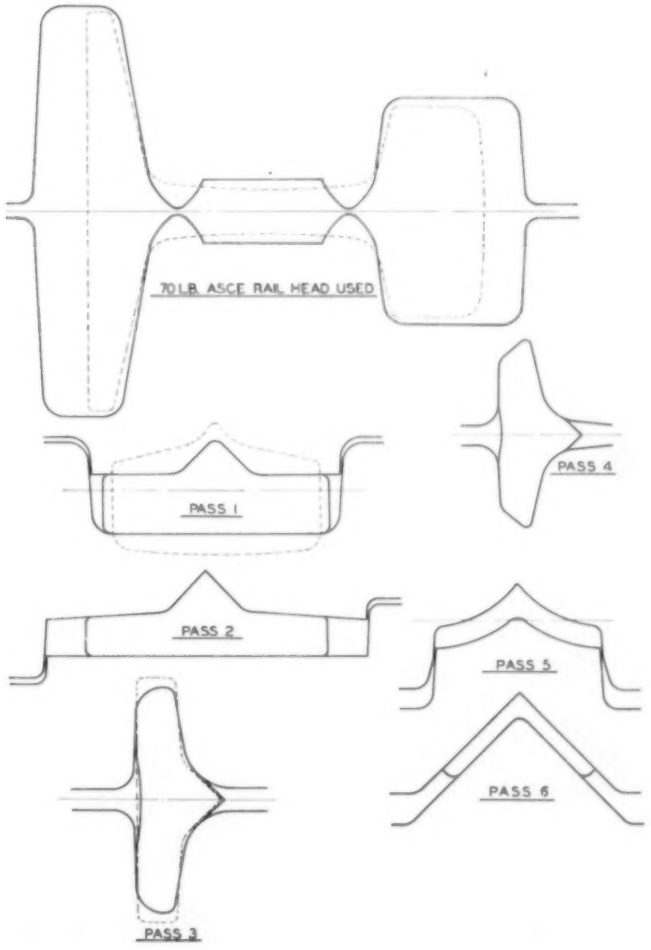
Because of this finishing pass angle, it is obligatory to set the leader at a different angle from that of the 6 × 3½-in. bulb angle just discussed. Figure 2 shows the position of this pass in the rolls with the left leg set so that it can readily be bent in the rolls. In passes 2–3–4 and 5 there is nothing special in the design. In pass 1, Figure 3, is shown a type of pass selected because it could be turned in available flat rolls. The formation is such that it rolls the 6¼ × 6¾-in. bloom and apportions the metal so that there is an abundance of it at the bulb side of the angle.

Drawing 29 shows a 10 × 3½-in. bulb angle. Although larger than the 6 × 3½-in. bulb angle, it is designed to be rolled in a similar way. The finishing pass is set in the rolls so that the short leg has an angle of 27 degrees, and in this way the bending in of the leader legs is easily accomplished. The other passes have the same characteristic design as previously discussed on the 6 × 3½-in. design.

ANGLE REDUCTIONS

The drafting of angles is relatively simple. In most angles the two legs are of the same thickness. In the finishing pass the draft is set according to the thickness of the legs. A ¼-in. leg is rarely drafted more than 1/16 in. making a leader thickness of 5/16 in. A ½-in. leg may receive in some cases as much as ⅛ in. reduction which is about the same percentage of reduction as the 1/16 in. on the ¼-in. leg. A series of angle passes are usually reduced in thickness to suit the thinnest leg size, and the intermediate and heavy leg sizes are rolled

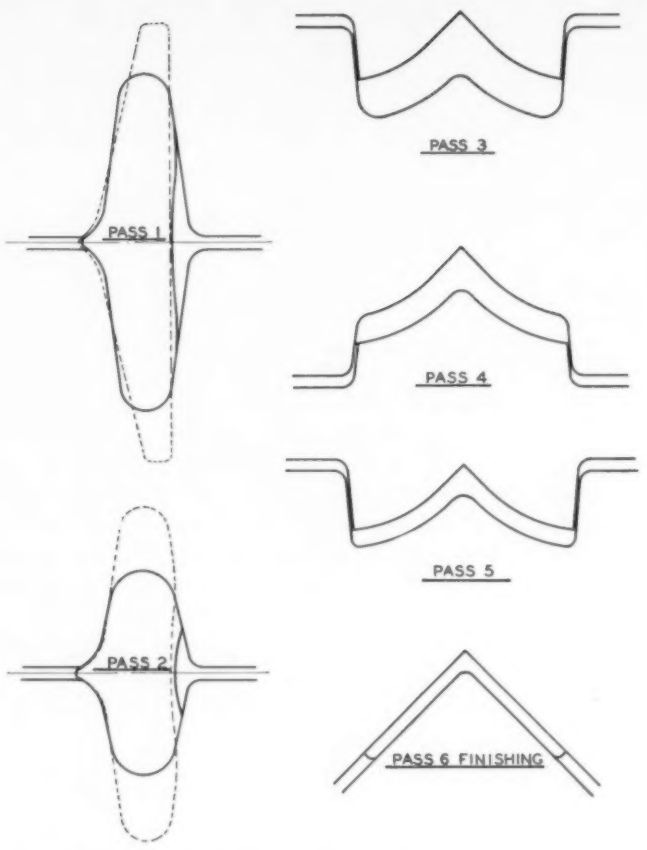
Drawing 23 — A 1¼ x 1¼ x 3/16-in. angle is rolled from the head of a 70-lb ASCE rail after slitting.



from the same roughing passes, in some cases raised slightly in thickness.

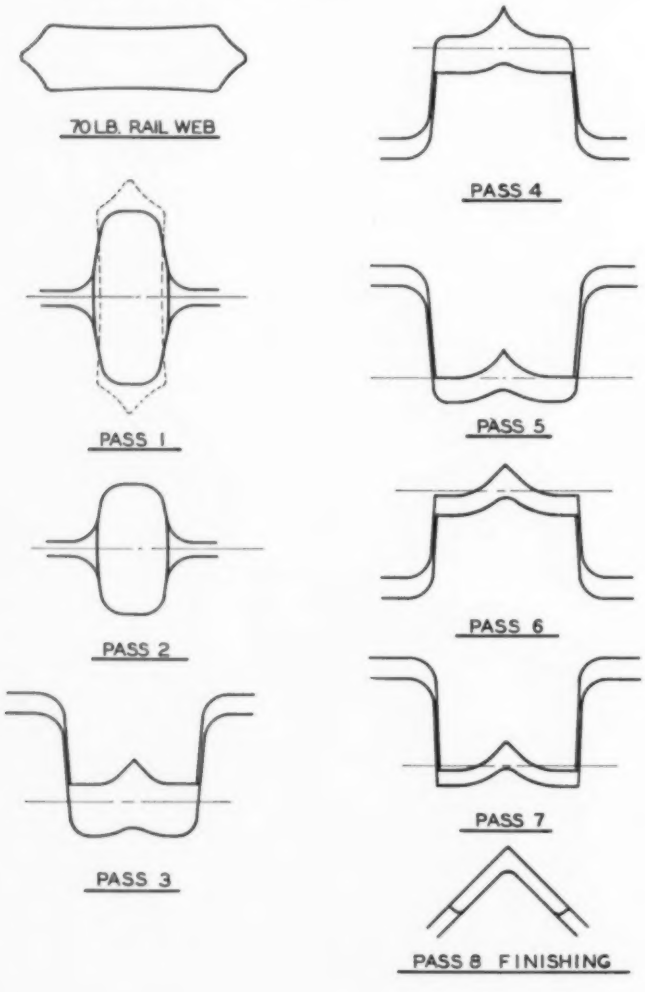
In the modern designs the sections are produced in the fewest passes that are practical. It is rarely found necessary to use more than seven shaped passes, and the thinner leg structural mill angles may be produced satisfactorily in as little as five passes.

In producing an angle from the slab stock used for the butterfly design of angles, the principal difficulty in the rolling is to fill the apex of the angle. In Drawing 30, a finishing pass is shown. Note the thickness "A" through the apex as compared to the leg thickness "B." This thickness "A" which is further increased by the thickness to the fillet "C," means that an increased area must be provided at this point in order to have proportionate ratios of elongation between the apex and the legs. Since a flat slab is used for stock, it is manifestly impossible to produce this in the earlier passes. In order to get an excess of metal into the apex as soon as possible, the roughing passes are heavily drafted. This heavy drafting in the first two or three passes of the section while the metal is soft and easily deformed provides the desired results. In order to assist in the formation of the apex it is customary to thicken the angle legs near the apex over the thickness at the ends to assure greater reduction at this point, and to cause metal to flow into the apex by reason of this greater reduction.

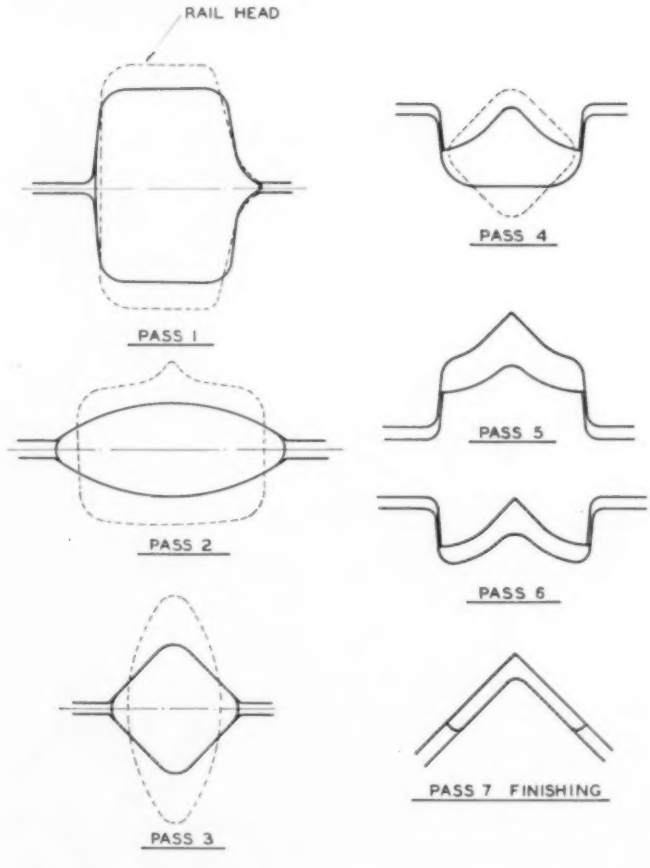


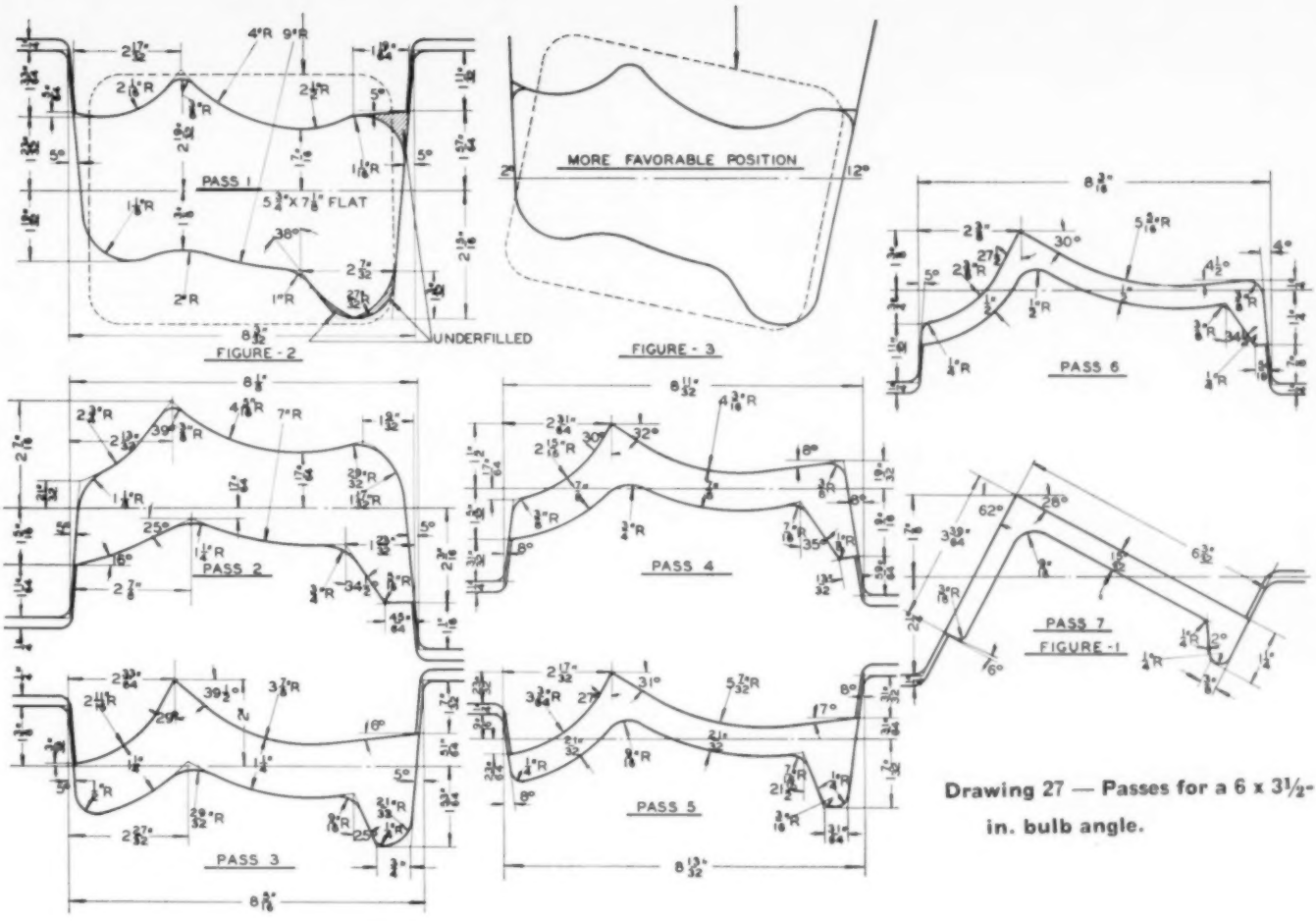
Drawing 25 — The flange of the 70-lb ASCE rail shown is rolled into a 1½ x 1½ x ⅛-in. angle.

Drawing 24 — The web of the 70-lb rail shown is rolled into a ¾ x ¾ x ⅛-in. angle.



Drawing 26 — This sketch shows how a 1 x 1 x ⅛-in. angle is rolled from a rail head.





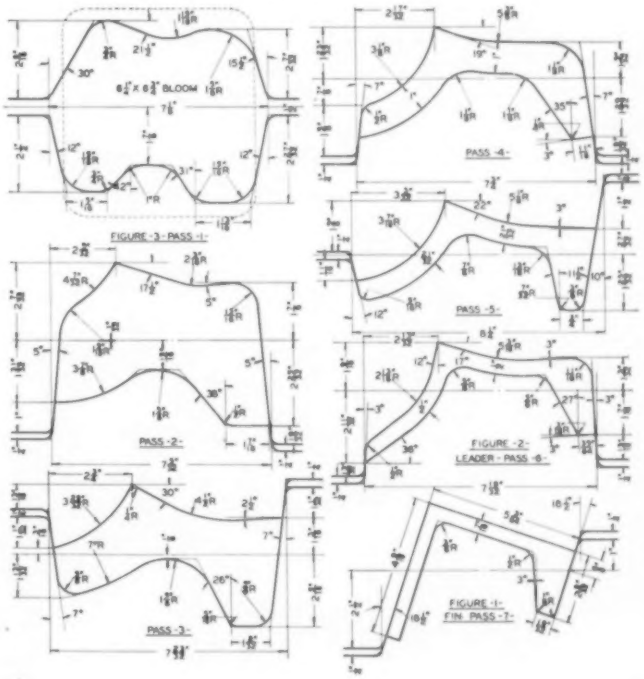
Drawing 27 — Passes for a 6 x 3½-in. bulb angle.

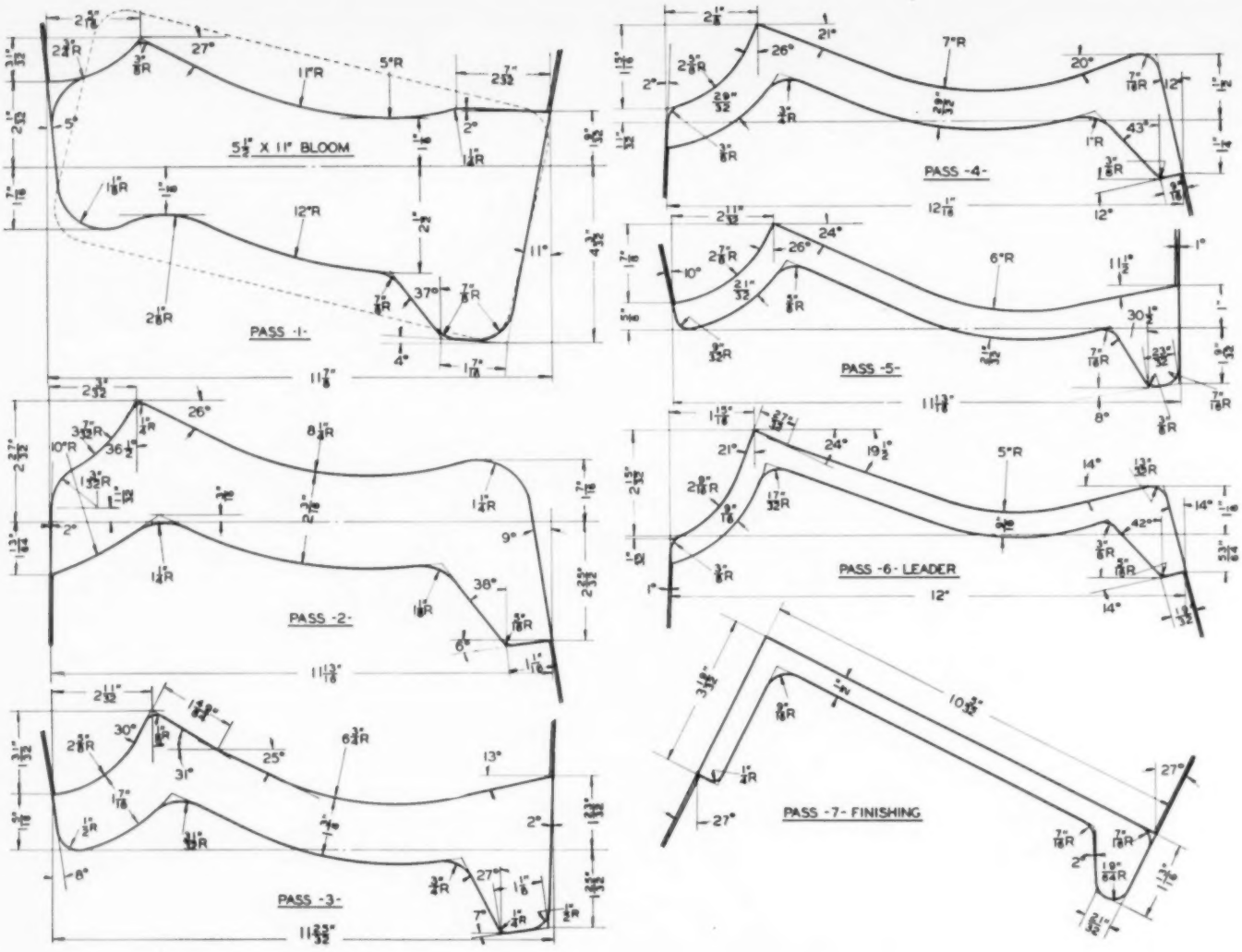
The drafting of the first passes of angles has limitations, one of which concerns the gripping angle of the rolls. Much has been written about the biting angle of the rolls; that is, the roll diameter which will take in the starting billet without hesitation. It is generally assumed that an angle of 30 degrees of contact of rolls on bars is the maximum angle that will pull the bar in the rolls. When the speed of the rolls is very slow and the effective gripping area is rough and heavily ragged, it is not uncommon to find a 30 degree angle of coverage or even slightly more, but for most mills it is advisable to use an angle somewhat less than 30 degrees.

Drawing 31 shows some sketches illustrating a first shape pass for a 4 × 4-in. angle, and the gripping angle of various diameter rolls on the bar. Figure 1 of the drawing shows a 5-in. thick slab entering the pass. This is the slab thickness used in this design. The pitch diameter of the rolls is 28 in. on the mill on which this angle is rolled, and the roll speed varies from 0 to 120 rpm. The maximum reduction on the pass is 1¼ in. The approximate gripping angle of the rolls is slightly over 18 degrees with the bottom roll angle 18 degrees 49 minutes and the top roll 18 degrees 09 minutes. The 1¼-in. reduction fills the pass; however, a 1½-in. reduction is within the "bite" of the rolls. With a 1½-in. draft the gripping angle is about 20 degrees. With an angle of 30 degrees the slab would be 7 in. thick, and this would give a reduction of 3¼ in. This is too great a reduction for rolls of this size running as they do at a fair rate of speed. Figure 2 of the drawing shows this same pass for 4 × 4-in. angles being rolled on a 20-in. pitch diameter pair of rolls with a 1¼-in. draft. The top roll biting angle of the 20-in. rolls is 24¼ degrees and the bottom roll 23¼ degrees. On the 20-in. roll, a gripping angle of 30 degrees would mean a slab thickness of $5\frac{29}{32}$ in. and a draft of $2\frac{5}{32}$ in.

In rolling and reducing a bar between two rolls, the

Drawing 28 — Passes for a 5 x 4½ x 7/16-in. bulb angle.

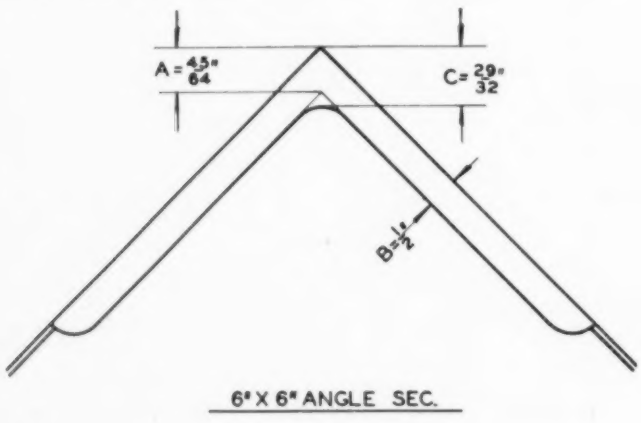




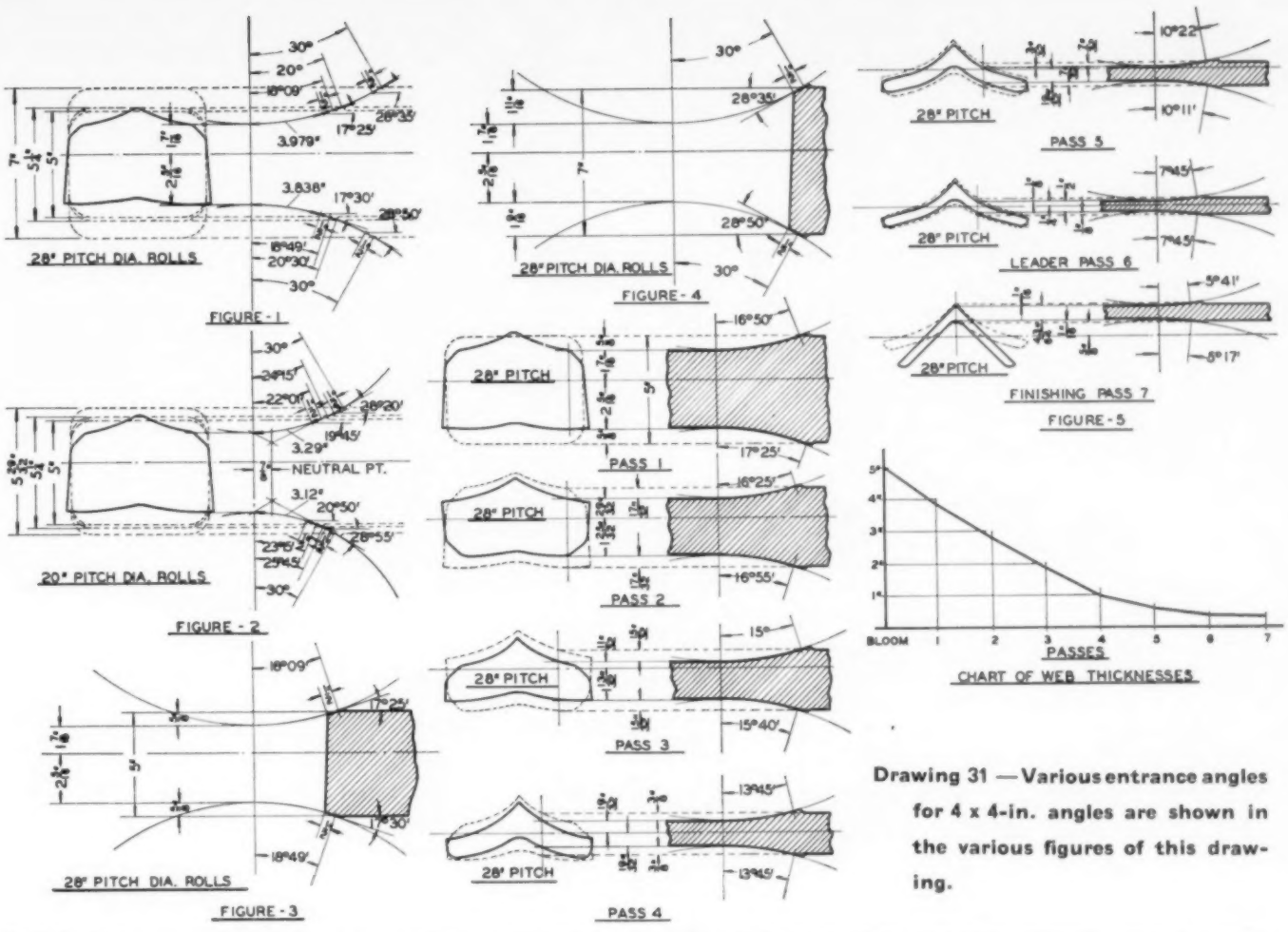
Drawing 29 — Passes for a 10 x 3½-in. bulb angle.

reduction in area of a bar such as we are discussing is considerable. It is evident by a reference to Figure 2 of Drawing 31 that with a peripheral speed of the rolls of 622 fpm, the entrance speed of the bar must be slower than the delivery speed due to the reduction in area. In other words the roll at the point of entrance of the bar is traveling faster than the bar. Referring to the sketch, note the location of the line marked neutral. A number of calculations and experiments have been made to determine the point where the speed of the rolls and the bar are identical, and it has been assumed that at this neutral point the speed of the bar and the rolls coincide. It is evident then that at the delivery point, or vertical center line of the rolls, the bar leaves faster than the roll speed, and at the entrance point, the rolls are traveling faster than the bar. By this reasoning, at all points except the neutral line, there is slippage between the bar and the rolls. When, at the point of entrance, the rolls are traveling faster than the bar, they tend to repel the bar. This action can be observed when a heavily drafted bar is seen to bounce back from its first attack at the rolls. Figure 3 of the drawing shows a 5-in. thick slab entered ½ in. into the 28-in. pitch rolls. The angle of this entrance of the bar is 17 degrees. A heavier draft would mean an increased angle and a greater repelling of the bar by the rolls. Figure 4 shows a 7-in. thick slab entering the same rolls. The end of the slab shows an angle of 29 degrees. It can be seen by these two sketches, and the factors just mentioned that the thicker bloom would not enter the rolls as readily as the thinner one due to the greater angle of contact.

Drawing 30 — The sketch details the apex of an angle finishing pass.



The problem then in determining the maximum draft that can be applied lies with the angle of coverage of the rolls on the bar. The smaller the angle, the less roll resistance to bar entrance and the better the grip. In practice it has been found desirable to confine the cover-



Drawing 31 — Various entrance angles for 4 x 4-in. angles are shown in the various figures of this drawing.

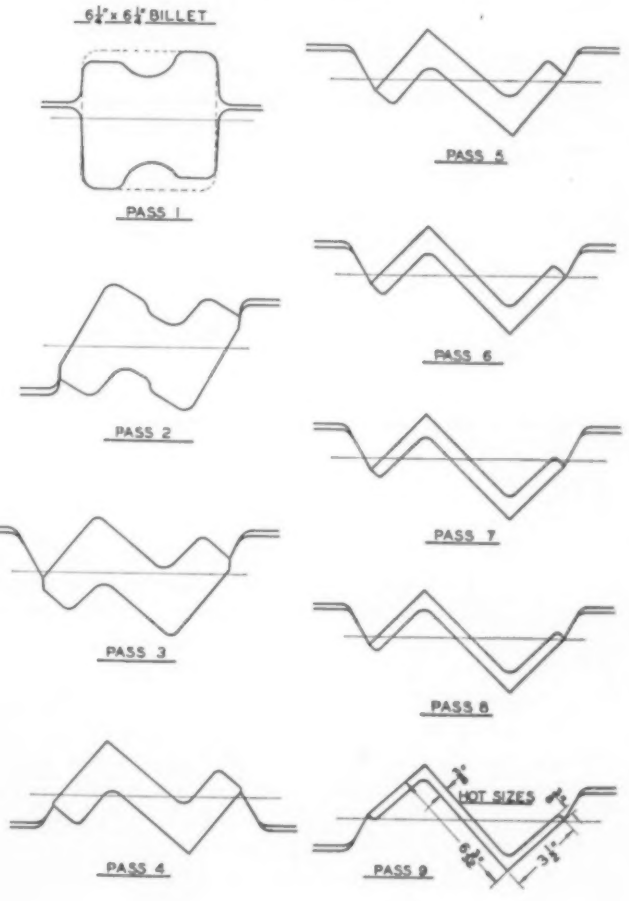
ing angle to considerably less than 30 degrees, and around 20 to 22 degrees is a good angle for rolls revolving at a fair rate of speed. With this angle of contact, the first pass should be adequately ragged to facilitate ready entrance of the bar. With the larger roll diameters, the smaller covering angle improves the gripping of the rolls.

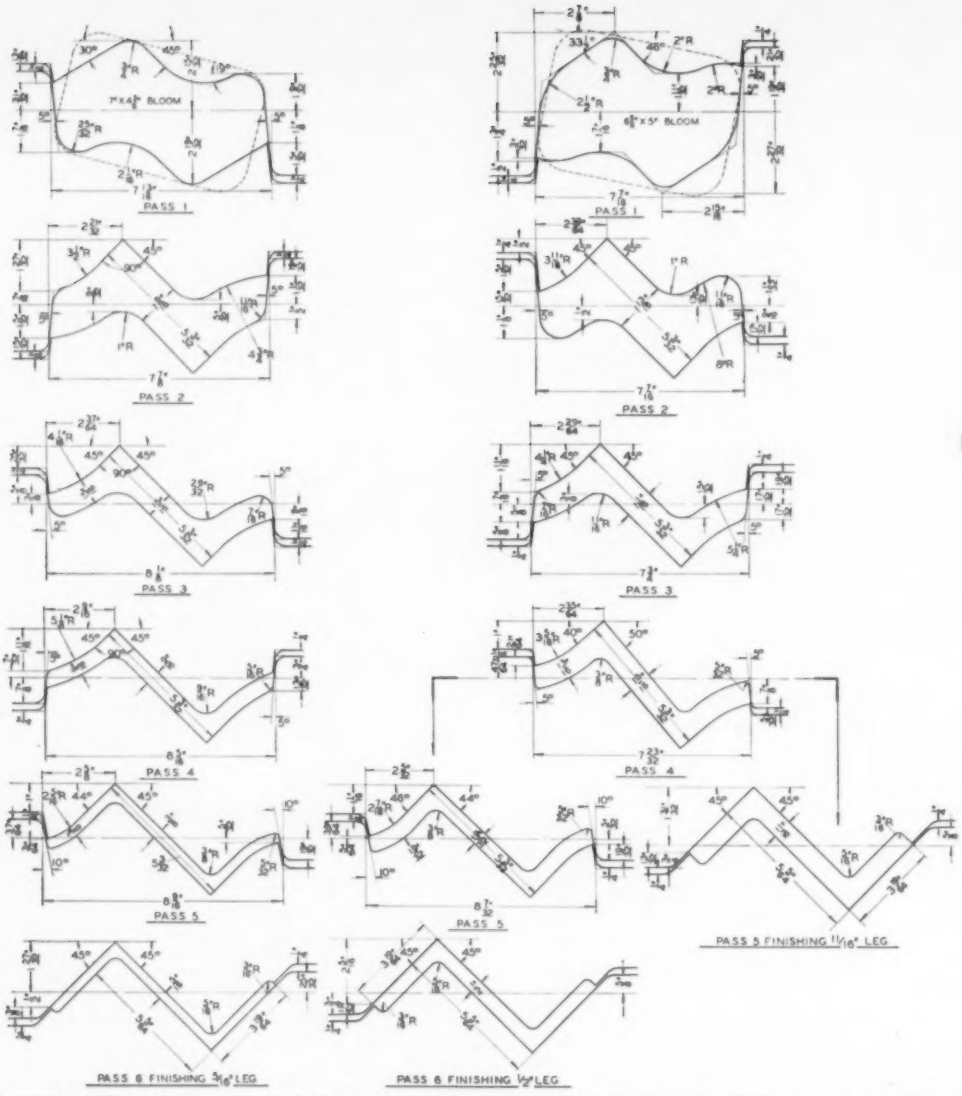
Examination of the other passes included in this angle design show that as the pass development of the angle progresses to the finishing, the angle of contact becomes less. This is not because of any gripping problems. It is necessary to reduce the vertical draft in inches, because as the bar becomes thinner it loses heat and resists further reduction, so that less draft must be given or rolls may be broken. It is also desirable to have light drafts in the finishing passes so that the roll surface may be kept smooth, which will result in a smooth finish on the finished section. The graph of the reductions of this 4 in. × 4 in. angle show the decreasing pattern of the drafts.

ZEE BARS

Zee bars are angles with another leg added, and all that has been said about angle pass formations applies in the main to zee bars also. One important difference, however, is that raising the finishing rolls to increase leg thicknesses increases the nominal depth of the zee, and this is permissible only to a slight degree. For this reason, it is customary to have three different size finishing passes for zee bars. The drafting of zees is quite similar to that applied in angles.

Drawing 32 — The pass design shown was used as early as 1897 in rolling 6 x 3½-in. zee bars.





Drawing 33 — Passes for 5 x 3-in. zee bar.

Drawing 32 shows an 1897 design for a 6-in. zee bar. This straight leg design has the same bad features at the roll partings as previously discussed in the section on straight leg angles.

Drawing 33 shows a design for 5-in. zees with the butterfly scheme carried out in all of the six passes used to roll the light and medium weights of the section. The heaviest weight of the zee is rolled in five passes. Due to this layout it is possible to roll the three weights in one set of ten rolls included in 4-roll stands of a cross-country mill. Drawing 34 shows the rolls of this section and it can readily be seen how the arrangement of passes in the rolls accomplishes the purpose.

GUIDES

The guides for angles and zee bars are fairly simple in design. The entering side guides for all passes except the finishing consist of plain vertical-sided guides, with or without shelves. Plain sided delivery side guides are made without shelves and with delivery pass guides to fit the contour of the pass. The entering guide for the finishing pass is one where a great deal of difference in design can be noted in the various plants rolling angles.

The most popular angle pass design now in use is the butterfly method, and a butterfly-shaped leader bar must be guided into the finishing pass with accuracy. For the reasons discussed earlier, a butterfly leader will not readily center itself in a finishing pass and must be held firmly in the proper position by the entering guides. There are a number of entering guide designs used for this purpose.

Drawing 35 shows an angle guide setup for a three-stand set of rolls. The top portion of the drawing, Figure 1, shows the entering side of the mill. Passes 1–3–5 and 7 show the entering guide set-up, while passes 2-4 and 6 show that for the delivery guides.

The next view, Figure 2, is the delivery side of the rolls, and passes 1–3–5 and 7 illustrate the delivery guides, while passes 2–4 and 6 show the entering side guides. On the delivery side pass guides it is sometimes necessary to use both hanging and resting guides as indicated by the dotted lines showing the top hanging guides of passes 2 and 4. On this particular mill design, however, top pass guides are not used on passes located between top and middle rolls with the exception of the leader and finishing passes. They are used on passes in the middle and bottom rolls to prevent bars from hooking up as the collars are on top of these passes. The bottom guides of these passes keep the bars from hooking under the table rollers. On uneven angles where top pass guides are not used, it is the custom in some mills to fasten an angle on one side of the delivery side guides to keep the bar from twisting, as it is inclined to do. Figure 3 shows this arrangement.

The entry finishing guide shown in Figure 4 is one popular on several mills and a good guide for the purpose. With this type of guide it is the practice on a number of mills to set the guide higher than the pass in order to hold the entering bar high in the apex of the finishing pass. Such procedure assists in holding the bar in line and at the same time tends to sharpen the apex of the finished bar. This guide may be set even with the pass, or in extreme cases, as in one known instance, 3 in. higher than the finishing pass.

Figures 5 and 6 show some other finishing pass entry guides now in use in some structural mills.

In guiding the uneven angle leader into the finishing pass and particularly when using the entering guides with shelves as shown on Drawing 35, Figure 5, it has been found necessary to have the shelf on the short leg side ½ in. or more higher on that side than on the long leg side. The tendency of the long leg to crowd toward the short leg side as previously described is corrected to a certain extent by this arrangement.

ANGLE SPLICE BARS

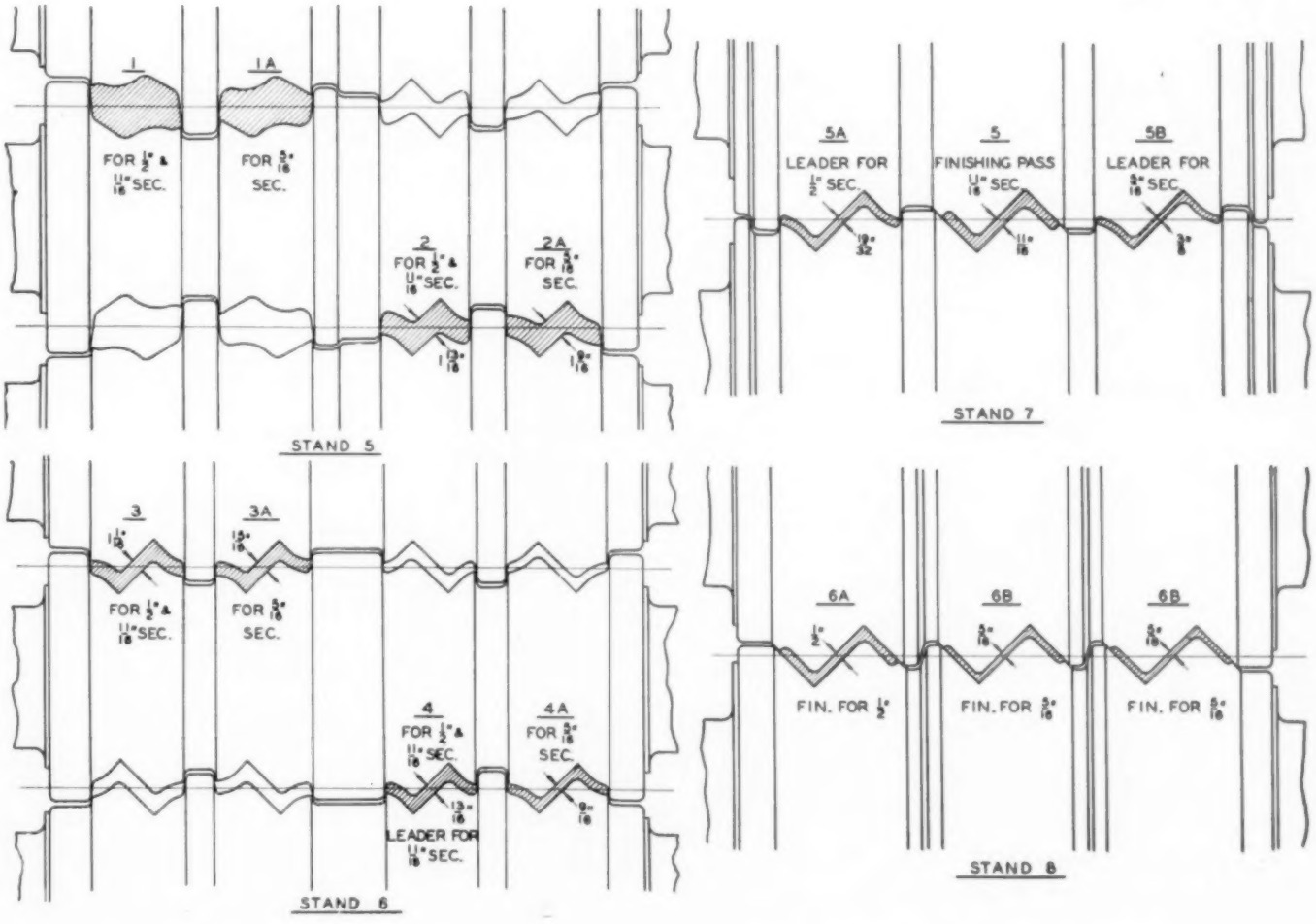
In the design of angular sections, angle splice bars, the so-called rail connections, are among the most important.

When Robert L. Stevens of the Camden and Amboy Railways designed the first tee rail and had it rolled in Wales, he designed a rail connection at the same time. The first connections, simple in form, were a flat bar with curved ends to fit the rail fishing similar to the pass design of Drawing 36. Later, more elaborate forms were developed, among which were angle splice bars. The first and simpler forms of these were in use for some time before they were changed and made more complex in design. The earlier design had long legs or toes, but in late years the tendency has been toward a short leg. In no other branch of rolling can we find so many different bar designs; they are too numerous for illustration. In one plant over 20 different designs were rolled at various times for the same rail size.

Since it is impractical to cover all of the different forms of angle splice bars which have been rolled in the past, this paper will be confined to the pass design features of a selected few bars in which some peculiarities have affected the pass design.

In the design of passes for angle splice bar, the starting point is with the finishing pass, and the first problem to be decided in the layout is the position of the finishing pass in the rolls. Drawing 37, Figure 1 shows what, in our opinion, is the best position in the rolls for an angle splice bar finishing pass. Figure 2 shows another possibility, but in this position the head

Drawing 34 — The drawing gives rolls and pass arrangement for 5-in. zee bars with 5/16, ½ and 11/16-in. sections.



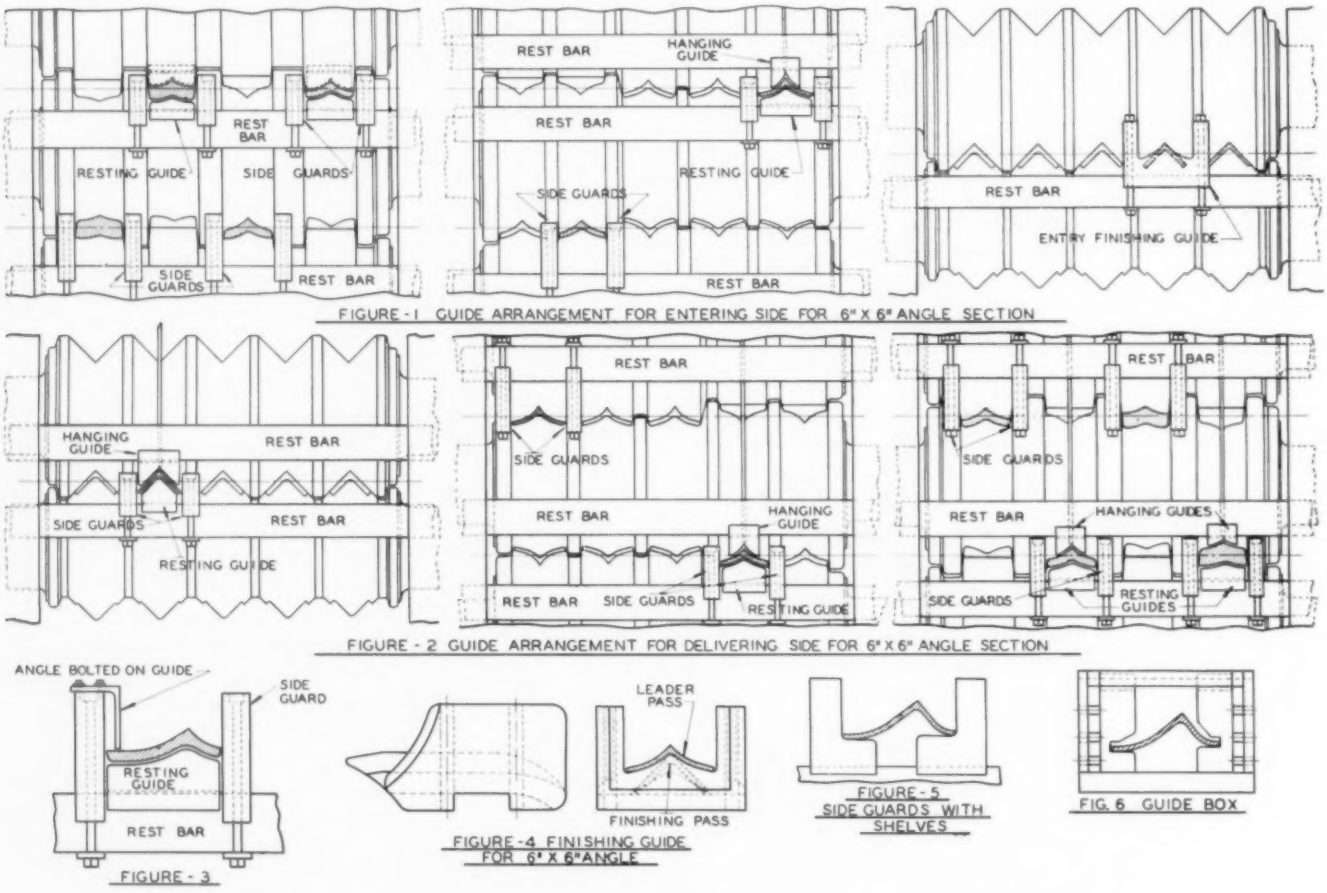
radius, part "A," which must fit into the upper part of the fishing under the rail head, will be finished irregularly as the roll parting occurs here and variations in temperature and draft will affect this radius and it will vary in size. Referring back to Figure 1, note that the part "A" is finished in a closed part of the pass and will vary only through underfilling or pass wear. In a good pass design there will be no underfilling at this point, and an accurate contour of the bar can be furnished. The position shown in Figure 1 is the only practical way of setting the bar in the rolls. Another point which requires consideration is the lug on top of the head of the bar which cannot be tilted a great deal for satisfactory rolling.

Drawing 38 shows a complete angle splice bar design. In the more modern type of bars, such as this, the reinforcement on the back of the head is set close to the roll parting and should the roll collar confining the head of the finishing pass be carried straight up as shown by the dotted lines, the roll at this point would be very weak and would easily break. Drawing 38 shows this condition in the dotted collar line. To strengthen this collar on the head side, the pass is turned as shown in the full collar lines on the sketch, thickening the collar to the point where it will not readily break. This collar also acts as a bearing to hold the top roll from shifting to the right under the pressure of the side work on the toe.

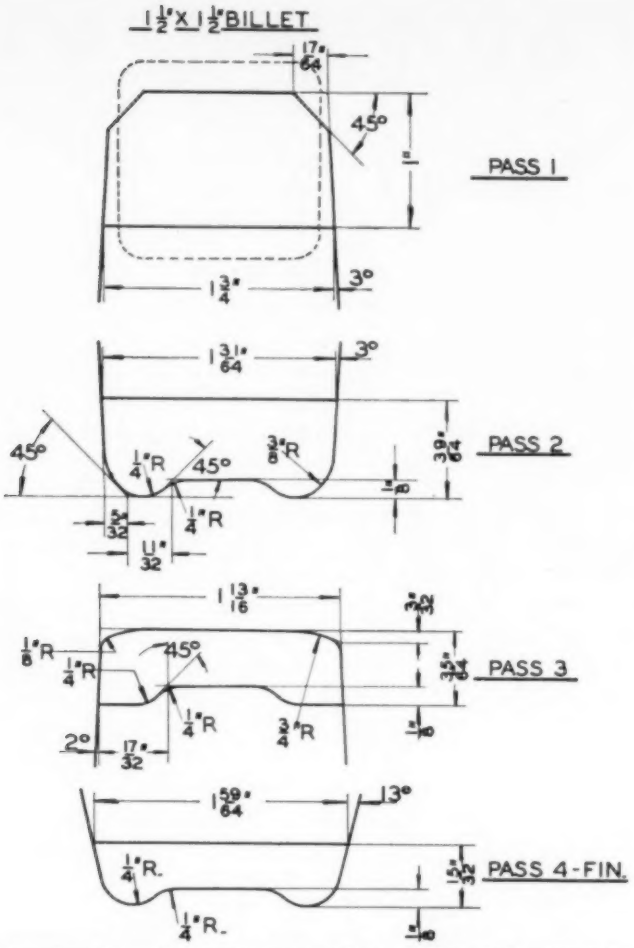
The amount of draft used on angle splice bars is adjusted to suit the web thickness and the design of the bar. In general about $\frac{1}{8}$ in. reduction is allowed for the web on the finishing pass and other parts in proportion. The only exception to this rule is when the web is corrugated as it is in some designs. In the corrugated web design, sufficient draft must be given to fill the depth of the corrugation which in some cases is $\frac{3}{16}$ in. The most important dimension on an angle splice bar is the fishing. The angular sides of the bar which fit into the rail are referred to as the fishing of the bar. Angle splice bar finished fishings are rolled to 0.020 in. maximum variation in size. The variation is usually preferred all over, and nothing under, by a great many railroads and the inspection is strict in regard to this tolerance. Since it is so important to have the fishing close in size, it is customary to use female templets with plus and minus sizes to inspect the bars. The head of the bar also must be correct as to inside radius, and flat where it fits the underside of the rail head.

The side reduction of the toe of the finishing pass, as indicated in Figure 1 of the drawing, cannot be too great or shearing will develop on the inside of the toe due to the small angle of that part in the rolls.

The leader pass, as indicated in dotted lines in Figure 1 of Drawing 38 is some $\frac{3}{64}$ in. wider than the finishing pass. The reason for this side draft is that there is considerable variation in temperature of the bars on front, middle, and back as they are rolled through the mill, and the front and back ends are usually colder than the middle. The middle of the bar being hotter than the ends, does not spread as much,



Drawing 35 — Various guides used for angle rolling are given in these diagrams.



Drawing 36 — An early method of rolling fish plates for 25-lb rails is given in this sketch.

Drawing 37 — Illustrated in this drawing are the finishing pass angles for a modern angle splice bar.

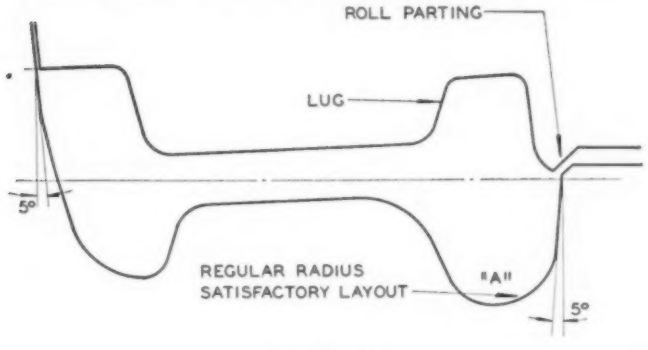


FIGURE - 1

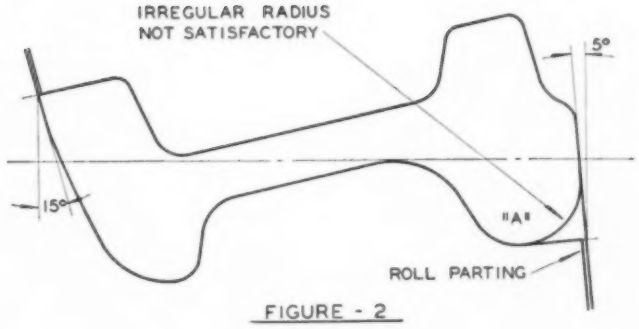
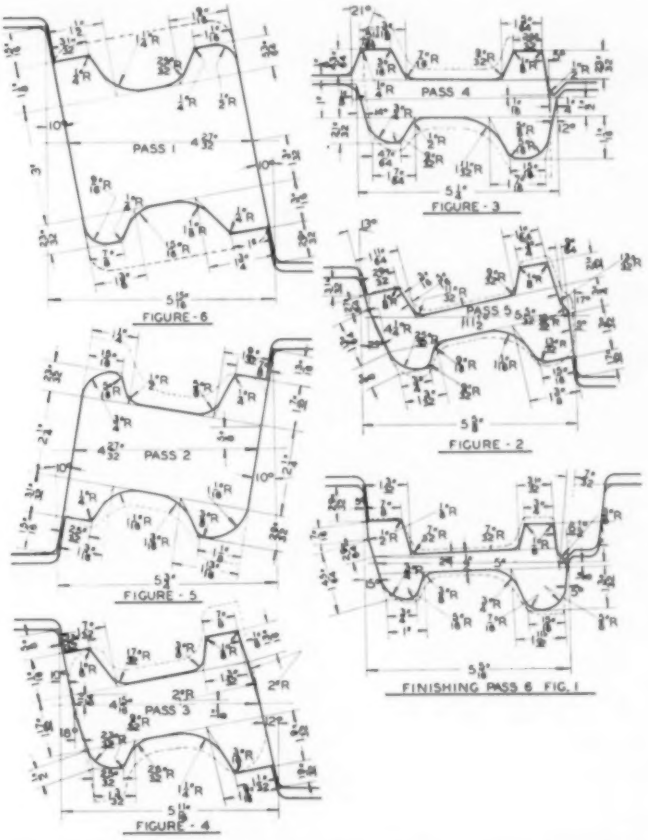


FIGURE - 2

and when the leader has the same fishing height as the finishing pass, the finished bar is inclined to be rounded where it should be flat.

The leader pass is turned in the rolls as shown in Figure 2. This puts the roll opening of the pass on the head side in the opposite direction from the head collar of the finishing pass, and in a good position in regard to the work on the head side. The size of the radius "C" regulates the filling of the top corner of the head in the finishing pass, and the abundance of stock at part "D" insures that the bottom of the head will be completely filled in the finishing pass. On the other side of the bar, the roll parting is taken off in the same direction as the finishing pass, and it would be preferable to reverse this collar if it were practical. The angle of the pass, however, makes the reversing of the roll



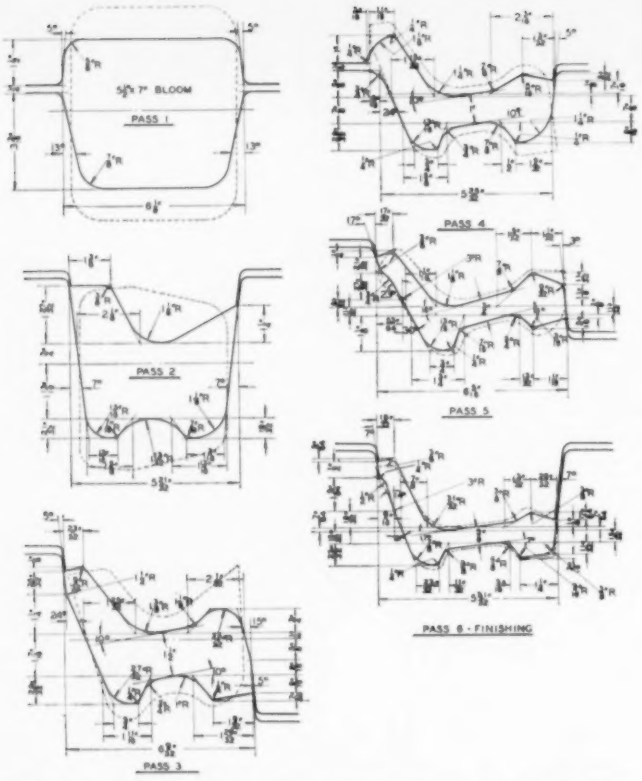
Drawing 38 — Rolling passes are shown for a 13225 angle splice bar.

parting difficult as it is necessary to have this part of the bar at a good angle with the pitch line to allow for the considerable toe reduction which is taken in this pass. The greater the angle, the greater may be the reduction at this point.

By experience and close checking in the rolling of several hundred different angle splice bars, it has been found that side work on the head at the finishing pass of the bar of $\frac{1}{32}$ in. to $\frac{3}{64}$ in. will give a flat head at all temperatures of the bar.

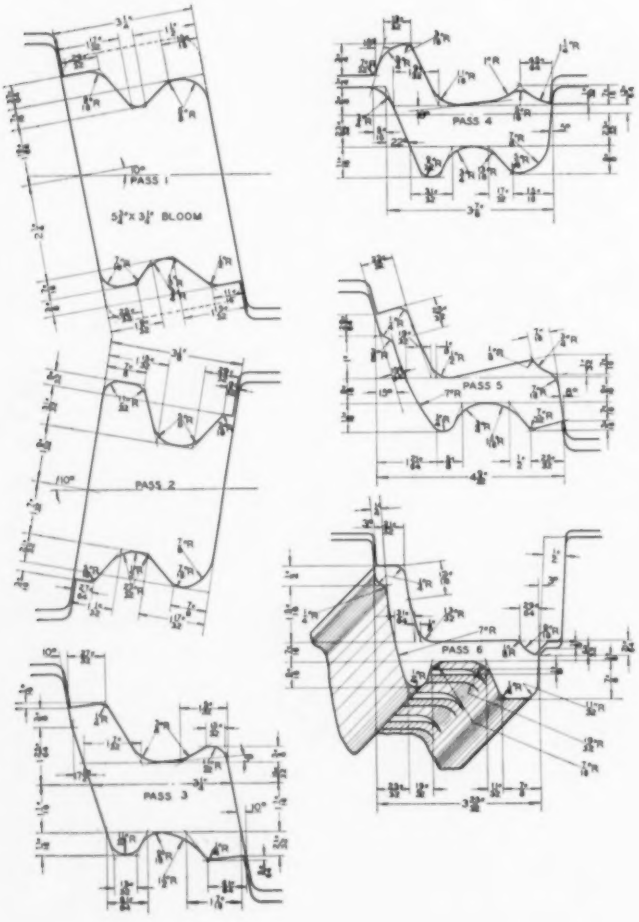
The drafting of the leader pass is as shown in the dotted lines of Figure 2 of the drawing. The web work in this pass is about $\frac{1}{4}$ in. An equivalent amount of work is allowed on the inside of the toe, namely $\frac{3}{16}$ in. and $\frac{5}{16}$ in. as shown in the figures.

The work on the head of the leader pass is in propor-



Drawing 39 — Rolling passes are shown for a 12722 angle splice bar.

Drawing 40 — Drawing shows passes for a 9030 angle splice bar.



tion to the work on the web and flange. The lower part of the head of the bar must be slightly underfilled, as shown in Figure 2, because if overfilled at the roll opening, an undesirable lap would be formed in the finished bar and cause rejection.

The head projection or reinforcement on the top of the bar shown must be drafted sideways very exactly in all passes, or it will be underfilled through being stretched by the elongation of the bar. The drafts indicated in the various figures are the correct ones.

The next pass, Figure 3, is the one which regulates the overall length of the left-hand side of the bar, and the roll parting on the head side of the bar is the reverse of the pass illustrated in Figure 2. The toe side has the roll opening at the side. The same problem in regard to collar strength on the head side of the bar is found in this pass, but since this roll collar is not used as a bearing, it is strengthened as shown in the figure.

The web work on this pass is $\frac{17}{32}$ in. and the head work is in proportion. The toe work on this pass is not proportionate to the other parts of the bar. Should the opening at the side of the toe be drafted as heavily as the web and head, a heavy overfill will develop at this point which will be wiped up in the next pass for a lap. The indicated draft will fill the toe correctly. This pass is the one which regulates the overall toe length and by adjusting the pass for overall thickness, plus or minus, a longer or shorter toe is developed in the next pass. Too great a variation in gage, however, will affect the head dimension of the leader pass adversely causing an overfilled or underfilled head in the leader.

Figure 4 shows the next pass in the formation, one which has the roll partings of the groove taken differently from the last figure. This pass is on the diagonal and has the same general characteristics as the leader.

The passes shown in Figures 5 and 6 complete the design. Figure 5 shows the second roughing pass in the series and is also on the diagonal. This pass is the groove which in conjunction with pass 1 produces the head projections or lug, and also develops the toe length. Pass 1, Figure 6, the first forming pass, shapes the billet and starts the pass formation.

While this section could be produced in five passes, the layout of the mill compels six passes to be taken. Advantage of this fact is taken by shaping pass 1 to assist in forming the left-hand side of the bar which is longer than the right. This section drawing represents one of the newer designs.

Drawing 39 shows another type bar and the six pass formation. The drafting in the finishing and intermediate passes is much the same as in the section just described, but the first two passes of this design are formed differently. Pass 1, a form of box pass, cuts into the web and prepares it for further drafting in the second pass, a tongue and groove design. This type design is sometimes advantageous for long toe bars.

Drawing 40 illustrates a corrugated web section without a head projection and with a $\frac{1}{8}$-in. corrugation. A leader web thickness of $\frac{5}{8}$ in gives ample reduction to fill the corrugation.

It is recognized that this paper does not by any means completely cover the field of roll design for angles, zee bars, and angle splice bars, but it should provide a fair idea of the problems involved to students of roll design.

PROBLEMS OF AIR POLLUTION

. . . . it is essential for industry to gather data on quantities and nature of air pollutants so that economical control equipment may be developed . . . . such data can also influence and help in the formulation of reasonable and adequate air pollution abatement legislation . . . .

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Industrial Hygiene Engineer
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▲ THERE are many people who have heard of air pollution for the first time only recently. It has, however, been with us to some degree at least since time immemorial. That the growth and mechanization of industry (including the transportation industry) is responsible for the bulk of the atmospheric wastes can hardly be denied, but industry is by no means the only offender. Even before man's advent on this earth there was air pollution produced by the action of the wind on the sand in the desert, and on soil in other barren areas, by pollen and other seeds from vegetation as well as decaying leaves, by salt particles from evaporated ocean spray, by volcanic ash, and by other similar materials. Today these sources of pollution are minor by comparison with those man-made in character, but to the hay-fever victim and those who suffer from other similar allergies this source of contamination cannot be discounted.

Until recently, only smoke of all the many and varied pollutants commanded significant attention. Thus the term "smoke abatement" has been in common use for many years, and even now is thought of by some as synonomous with "air pollution control." As long ago as 1306, Edward I issued a proclamation prohibiting the use of sea coal by artificers in their furnaces, and he appointed a commission to seek out and punish violators. Air pollution control has received attention abroad ever since that date, sulfur dioxide having entered the picture at least as early as 1881. In America smoke abatement assumed a place of importance only since the turn of the century. Because of our flair for doing everything on a colossal scale, the amount of waste dumped into the atmosphere increased much more rapidly than elsewhere with the result that our waste production and discharge rate outdistanced the rather feeble control efforts by handsome and rapidly increasing proportions.

CONTAMINANTS

Atmospheric pollutants as thought of at present in this country are made up of two major types. First, the group including smoke, soot, fly ash, cinders, etc., resulting from the incomplete combustion of fuel in the home, in railroad locomotives, and the like, as well as in industry; and second, that large and varied group of fumes, mists, gases and dusts produced in industrial operations. There are other pollutants which by comparison are of little significance, namely, rubber dust from tires and the concrete or road dust produced by traffic; household dust; dirt from construction projects, from the threshing of grain, from plowing and harrowing in dry weather, and the like. Even though almost any conceivable material may and sometimes does enter the air as a pollutant, those of most importance are fly ash, carbon, oxides of metals, silicates, silica, sulfur dioxide, carbon monoxide, carbon dioxide, hydrogen sulfide, oxides of nitrogen, hydrofluoric acid, hydrochloric acid, ammonia and organic solvents.

Air pollution does not connote the same meaning to all people. To residents of Los Angeles it means one thing, to residents of St. Louis another, to residents of Donora another, and to those of Ducktown, Tenn., still another. To one group it may be associated with irritation of the eyes, to another darkness at midday with the accompanying laundry problem, to another health implications, and to still another barren hillsides. The pollution may be caused by only one important pollutant or it may be made up of many; it is seldom the same from community to community either as to its composition or as to the concentration of the different ingredients in the air.

What about the concentration of pollutants in the air? Considerable study has been devoted to the measurement of air pollution in different communities during the last four decades. One of the major investigations of this kind was that made by the U. S. Public Health Service from 1931 to 1933[1].* This study covered fourteen large cities, namely, Baltimore, Boston, Buffalo, Chicago, Cleveland, Detroit, Los Angeles, New Orleans, New York, Philadelphia, Pittsburgh, San Francisco, St. Louis and Washington, D. C. Gaseous

*Figures in parenthesis refer to bibliography at end of article.

TABLE I

City	Sulfur dioxide concentrations in ppm† at following distances from center in miles						
	0-5	5-10	10-15	15-20	20-25	25-30	Total Ave.
Detroit	0.023 (0.228)*	0.012 (0.140)	0.006 (0.139)	0.004 (0.056)	0.004 (0.044)	0.005 (0.144)	0.014
Philadelphia-Camden	0.030 (0.424)*	0.018 (0.228)	0.016 (0.335)	0.021 (0.415)	0.012 (0.062)	0.012 (0.073)	0.022
Pittsburgh	0.060 (0.828)*	0.030 (0.449)	0.015 (0.157)	0.018 (0.218)	0.009 (0.113)	0.010 (0.084)	0.038
St. Louis-E. St. Louis	0.111 (1.080)*	0.048 (0.529)	0.029 (0.266)	0.020 (0.205)	0.018 (0.209)	0.014 (0.153)	0.060
Washington	0.003 (0.086)*	0.001 (0.047)	0.001 (0.035)	0.001 (0.036)	0.001 (0.012)	0.002 (0.047)	0.002

†Parts of sulfur dioxide per million parts of air by volume.
*Values in parentheses represent maximum readings obtained.

contaminants were not measured. The concentrations and composition of suspended solid pollutants were determined by collection in the Greenburg-Smith impinger and appropriate laboratory treatment. Unfortunately the concentrations and composition were not given by city, but on the basis of the findings the cities were divided into three groups of about equal number according to the degree of pollution. Thus Baltimore, Boston, Chicago, Pittsburgh and St. Louis fell in the group having the greatest pollution; Buffalo, Cleveland, New Orleans, New York and Philadelphia in the middle group; and Detroit, Los Angeles, San Francisco and Washington in the group having the least degree of pollution. The average amount of airborne solids for the first group was 0.63 mg/m³ (milligrams per cubic meter), for the middle group 0.52 mg/m³, and for the third group 0.35 mg/m³. Analysis of composited samples including all cities showed the material to be 65 per cent carbonaceous matter, and 35 per cent ash of which 12 per cent was silica and 2 per cent iron oxide.

In 1936 and 1937 the city of New York conducted an air-pollution survey of the city[2]. The survey included bacteria concentrations, fuel consumption and control equipment data, sootfall, and suspended particulate matter concentrations. Only the last two investigations are germane to this report. The total solids settling out of the air in New York City averaged 55 tons per square mile per month. For Manhattan it was 108, for the Bronx 53, for Brooklyn 57, for Queens 44 and for Richmond 42 tons per square mile per month. Atmospheric particulate matter was collected by means of the Greenburg-Smith impinger and measured by number concentration rather than weight concentration as was done by the Public Health Service. For the entire city the concentration of suspended solid particles ranged from 0.25 mppcf (millions of particles per cubic foot of air) to 3.5 mppcf, and averaged 0.9 mppcf. It is unfortunate that this unit of measurement was used rather than weight, because it prevents comparison of results with those reported by the Public Health Service.

About the same time (1936 to 1937) the Air Hygiene Foundation located in Mellon Institute carried out an extensive study of sulfur dioxide concentrations in five large population centers, namely, Detroit, Philadelphia-Camden, Pittsburgh, St. Louis-East St. Louis, and Washington, D. C.[3]. Thousands of measurements were made in each district and the results were grouped according to the geographical distance from the center of the urban area under study. The findings are summarized in Table I.

In addition to these five population centers in which thorough studies were made, some measurements were made of the sulfur dioxide concentrations in twenty other cities. The number of individual measurements varied from as few as 13 in Louisville to as many as 908 in Chicago, the median number being 72. The cities and the concentrations found are shown in Table II.

TABLE II

City	Sulfur dioxide concentrations found in ppm	
	Average	Maximum
Altoona	0.008	0.024
Atlanta	0.012	0.069
Baltimore	0.021	0.366
Birmingham	0.017	0.087
Charlotte	0.015	0.050
Chattanooga	0.011	0.044
Chicago	0.067	1.141
Cincinnati	0.021	0.107
Cleveland	0.064	0.281
Ft. Wayne	0.028	0.309
Harrisburg	0.011	0.037
Indianapolis	0.023	0.093
Johnstown	0.014	0.038
Louisville	0.022	0.119
Nashville	0.028	0.119
Richmond (Va.)	0.009	0.025
Springfield (Ill.)	0.021	0.169
Toledo	0.023	0.072
Wheeling	0.070	0.320
Youngstown	0.049	0.162

Because of the periodic eye irritation caused by the air pollution in the Los Angeles area, Stanford Research Institute began a long range investigation into the pollution problem in 1947[4]. This work included measurement of atmospheric pollutant composition and concentrations. The atmospheric waste responsibile for the so-called Los Angeles smog is produced by a complex mixture of more than 40 separate contaminants.

They include ammonia, aldehydes, sulfur dioxide, sulfur trioxide, oxides of nitrogen, gaseous hydrocarbons, ozone, oil droplets, nitric acid droplets, sulfuric acid droplets, calcium, sodium, aluminum, silicon compounds, magnesium, titanium, lead, iron, potassium, barium, fibers, pollen, carbon, tarry organic materials, and traces of about 15 other substances. On smoggy days sulfur dioxide was found in concentrations averaging about 0.1 ppm by volume, ammonia averaging 0.1 ppm by volume, and aldehydes in an average concentration of about 0.15 ppm by weight. The concentrations of total solids in the area as collected in a commercial precipitron were found to average not more than 0.1 ppm by weight. This is equivalent to 0.12 mg/m³, which is low compared with the concentration of suspended solids reported by the Public Health Service for 14 U. S. cities and referred to earlier. The dust fall for 1946 averaged 27.7 tons per square mile per month, which is low compared to that of New York City.

Of interest in the Los Angeles study is the fact that it has not yet been established definitely what causes the eye irritation on smoggy days since all individual constituents of the polluting material are present in concentrations much below that required to produce comparable effects. Recently reconstituted synthetic smogs have been tested. These have been made up of certain of the ingredients known to be present when eye irritation is prevalent. The concentrations of the ingredients are about as high as the maximum measured, but are way below the amounts required individually to produce irritation. The results to date show great promise since the effects on the eyes are greater than would be anticipated from the additive effects of the separate components. Another investigative approach that holds promise is the inclusion of mineral oil in the atmosphere with single irritants in low concentration. The few data obtained thus far indicate that the addition of mineral oil increases the eye, nose and throat irritation a great deal.

Early in 1949 the U. S. Public Health Service made an air pollution survey in the Donora area because of the episode that occurred there in October 1948[5]. This survey was a very complete one. The atmospheric investigation, for example, included a study of the amount of coal burned by the local and through trains while in the area in question, a study of the coal burned by the boats engaged in river traffic while passing through the zone of influence, a study of the approximate amount of carbon monoxide produced by automobile traffic in the area under investigation, a study of the rate and type of contaminants discharged by the industries and other buildings in the community, and a study of the composition and concentrations of the atmospheric pollution. Only the last part of the investigation is of immediate interest in this discussion. Unfortunately, the method of reporting the results is unlike that used elsewhere making it rather difficult to get a clear comparison.

When the nearby industry was operating at full scale 45 per cent of the sulfur dioxide concentrations measured at different locations in the town of Donora fell in the range of 0.00 to 0.09 ppm, 28 per cent in the 0.10 to 0.19 ppm range, 12 per cent in the 0.20 to 0.29 ppm range, 8 per cent in the 0.30 to 0.39 ppm range, 2 per cent in the 0.40 to 0.49 ppm range, and 5 per cent over 0.50 ppm. The total air-borne particulate matter under similar conditions of plant operation was found to range from 0.0 to 0.4 mg/m³ for 13 per cent of the measurements, from 0.5 to 0.9 for 19 per cent, from 1.0 to 1.4 for 34 per cent, from 1.5 to 1.9 for 9 per cent from 2.0 to 2.4 for 9 per cent, and 2.5 or over for 16 per cent of the measurements. These data do not permit an accurate calculation of the average concentrations found. An estimate of the approximate average concentrations from the foregoing results indicates the sulfur dioxide to have been in the vicinity of 0.15 ppm and the suspended particulate matter to have been 1.5 mg/m³. The median sulfur dioxide concentration was slightly above 0.10 ppm and the median particulate matter concentration was about 1.2 mg/m³. These average values are substantially higher than the comparable ones reported earlier in this paper for other cities.

Many other studies of this nature have been made since 1910. Some of the findings from these investigations will be summarized briefly to give a broader insight into the nature and amount of pollutants in the air of industrial cities.

In Chicago in 1912 and 1913 the air was found to contain 0.007 mg/m³ of nitrous acid, 0.010 of ammonia, 0.113 of chlorine, and 0.505 mg/m³ of sulfuric acid[6]. Carbon dioxide was present in an average concentration of 330 ppm. Suspended solid matter varied from 0.32 to 1.96 mg/m³ and averaged 0.77 mg/m³.

In Salt Lake City during the winter 1919-20 atmospheric chlorine varied from 0.002 to 0.034 mg/m³, ammonia from 0.001 to 0.080, and nitrous acid from 0.009 to 0.032 mg/m³ [7]. Sulfur dioxide varied from 0.0 to 0.8 ppm and averaged 0.036 ppm. Carbon dioxide varied from 270 to 430 ppm and averaged 335 ppm. The suspended solid matter varied from 0.1 to 2.5 mg/m³.

Settled soot or dust has been measured in a number of cities since 1910. Some of the findings that have been reported are: (1) Pittsburgh in 1912 and 1913 about 94 tons per square mile per month[8], in 1923 about 130 tons, and in 1929 about 95 tons[9]; (2) Salt Lake City in 1919 and 1920 about 24 tons[7]; (3) Grafton, W. Va. in 1922 about 156 tons[10]; (4) Cleveland in 1927 to 1929 about 66 tons per square mile per month of which 19 tons was carbon and 47 tons was ash including 10 tons of iron oxide[11]; (5) Baltimore in 1926 to 1928 about 150 tons per square mile per month in the center of the city, 67 tons three miles from the center, and about 28 tons about ten miles out in the country[12]; and (6) Chicago in 1947 about 768 tons, in 1948 about 699 tons, and for the first five months of 1949 about 340 tons per square mile per month[13].

METEOROLOGY AND TOPOGRAPHY

Time will not permit a discussion of the meterological and topographical aspects of air pollution other than to hint briefly at the great importance of these two factors. It requires little imagination to see that other things being equal the weather and topography determine the degree of air pollution that will exist in a given area. The influence of these factors is now so well understood in the Los Angeles area, for example, that periods of irritation can be determined in advance. In

explaining the Donora episode, Professor H. C. Willett of the Meteorology Department at M.I.T. stated recently that no other similar meteorological period has been found for the Donora area in the records of the Pittsburgh Weather Bureau[14]. The atmospheric inversion was such that the air temperature in Donora was lower than at the Pittsburgh Airport, a very abnormal condition and one not previously recorded. The wind velocity was very low from October 27th through the 30th, averaging 2 to 4 mph; it was about 8 mph at Pittsburgh. Prof. Willett stated that if Los Angeles had the Donora geography and pollutants with the Los Angeles meteorology, the area would be uninhabitable about half the time.

Because of a better understanding of the importance meteorology and topography play in atmospheric waste disposal, many industries today are building all new plants in areas and locations having favorable weather and geography. In at least one instance, the rate of discharge of a pollutant to the atmosphere is regulated according to the weather conditions[15]. In other words, the amount of waste treated in absorption towers is varied according to the concentration of the pollutant in the air at continuous-recording stations located downwind. As much as the atmosphere can carry with impunity is discharged; the remainder being processed in a by-products plant at a sacrifice in economy.

EFFECTS OF POLLUTION

The effects of air pollution may be divided conveniently into five main groups. They are (1) nuisance, (2) economics, (3) health, (4) vegetation, and (5) animals[16].

The nuisance aspects of air pollution are well known. It is very common to have action brought against an industry by a community, by an individual, or by another industry because of an alleged nuisance created by atmospheric waste discharged by the industry. These cases are sometimes very difficult of arbitration or adjudication because of the absence or lack of meaning of scientific data. At what point does atmospheric pollution become a nuisance? Even if a careful study is made of the concentration of gases and solid material in the air and of the amount of dust fall, at what level does it constitute a nuisance? A nuisance as defined by Webster is "an offensive, annoying, unpleasant, or obnoxious thing or practice; a cause or source of annoyance, especially a continuing or repeating invasion or disturbance of another's right. But a single act may be a nuisance." If the term nuisance is meant to include injury or damage it possesses something concrete — something that may be examined and evaluated. Yet, must a condition injure or damage to be a nuisance or to be real, not imagined. Anyone can think of a situation in which air pollution is or was a nuisance either to himself or to people whom he knows well without having caused any measurable damage or injury. It is cases of this type that tax the best we have in the way of ordinance, legislation, commissions and courts to insure that injustice shall befall neither the accuser nor the accused.

There is a common law pertaining to air pollution that is frequently referred to with respect to the existence of a nuisance. It says in effect that the emission of smoke or fumes or dust to the atmosphere may constitute a nuisance, either private or public, depending on the extent of the injury or damage. This, as suggested above, does not cover the situation where the pollution merely disturbs or annoys the individual or group without causing damage or injury.

Other familiar effects of air pollution are the discoloration of buildings, furnishings and clothing by smoke and soot, and the corrosion of buildings and structures by acid gases. These are economic in character. As early as 1912 one investigator estimated that smoke and gas in the air in the city of Pittsburgh cost its inhabitants about $10,000,000 annually[9]. It has been estimated that the air pollution in St. Louis prior to 1940 cost the inhabitants of that city about $14,000,000 annually [17], and the economic losses caused by air pollution is costing the U. S. an estimated $1,500,000,000 annually[18]. Only recently the paint on an undetermined number of automobiles parked in the parking lots of a manufacturing plant in Dayton was ruined by air pollution[19]. The estimated damage per car was $75 to $100 and an estimated 1500 cars were affected. It can hardly be denied that the laundry bill is higher in grossly polluted areas than in those having less pollution, and the cost of frequent "face-lifting" operations on blackened buildings is also higher in cities having much atmospheric pollution. As an illustration, it has been estimated that the people of St. Louis prior to 1940 were paying over $2,500,000 annually just for unnecessary renewing of paint and sheet metal. People engaged in the painting trade in St. Louis estimate that in 1945, five years after an active smoke abatement program was instituted, the wearing qualities of paints especially on exterior surfaces had increased at least 25 per cent. This figure alone in monetary savings amounts to about $250,000 annually.

Also economic but of a different type are the damage awards made to individuals or communities for injury to buildings. The amounts vary greatly but apparently have reached a figure of about $250,000 in one instance. A somewhat different type of economic effect is the absurdly high price sometimes paid to adjoining land owners for their property to dispose of an air pollution case or to forestall a series of them.

Stack gases are being sampled for solid material. (Courtesy, Industrial Hygiene Foundation, Inc.)

The effects of common and usual air pollution (excluding air-borne diseases of biological etiology and of plant origin) on the health of exposed persons is a moot question indeed. Except for instances such as the Meuse Valley disaster in Belgium in 1930 when about 80 people died and hundreds were made ill; the Donora incident in October, 1948, where 20 persons died and 5910 (42.7 per cent of the population) were affected; and the occasional eye, nose and throat irritation in the Los Angeles area, there are few if any reliable data to indicate any demonstrable effect on the health of exposed people. The absence of positive findings at present does not prove that there is no effect, but it does suggest strongly that there is no pronounced effect. Much more research and investigation are needed to answer this question and more particularly to isolate the offending agent or agents if health effects are found to exist so that correction of the condition may be brought about in a scientific and economical manner.

The Donora incident and the experience in the Los Angeles area have precipitated some new thinking with respect to safe levels of air pollution. Industrial hygienists for years have made use of safe limits commonly called maximum allowable concentrations in the evaluation of health hazards in industry[20]. These limits are the atmospheric concentrations of the particular materials to which all except possibly unusually susceptible individuals can be exposed eight hours daily during a normal working span of life without producing demonstrable effects upon their health. In all instances, these values are much higher than those encountered in highly polluted areas including Los Angeles, and Donora at the time of the Public Health Service survey. There is little doubt that the maximum allowable concentrations so useful to industrial hygienists will have to be discarded completely by workers in air pollution control because (1) the public is exposed to air pollutants 24 hours daily, 7 days weekly rather than 8 hours daily for 5 days each week, (2) the public includes many elderly people and many others who are ill rather than only those of working age and almost wholly devoid of significant illness, and (3) combinations of different polluting materials in extremely low concentrations may have an effect far in excess of the anticipated additive effects of the separate components. Different standards will have to be used in the future by those official agencies responsible for air pollution control to determine whether a health hazard may exist or not in case of controversy.

The effect of excessive atmospheric pollutants especially sulfur dioxide on vegetation is now well recognized. Outstanding examples of vegetation destruction by sulfur dioxide are the areas surrounding the smelters at Ducktown, Tenn., Anaconda, Mont., Salt Lake City, Utah, and Trail, British Columbia[21]. The problem at Ducktown was settled in the U. S. Supreme Court and that at Trail, B. C. before an International Joint Boundary Commission and later before an International Tribunal at which time damages amounting to $78,000 were awarded.

In addition to the outright destruction of all vegetation, sulfur dioxide in some localities prevents the growth of sensitive plants while permitting others less sensitive to grow at reduced rates. Most, if not all, of the people present this evening can recall industrial areas at no great distance from Philadelphia where the absence of certain plants and the ghostlike appearance of evergreen trees attests to the effects of atmospheric pollution. The study done by Lathe and McCallum for the National Research Council of Canada in connection with the smelter at Trail, B. C., showed conclusively that the growth of Douglas fir, yellow pine, and ledgepole pine located in the zone of sulfur dioxide influence was less than that of these same varieties located in areas outside the influence of sulfur dioxide[22]. The experience in the Missouri Botanical Garden in St. Louis has been similar [17]. Prior to 1940 such plants as begonias, cinerarias, tropical water lilies, and fuchsias would become entirely defoliated in a single 24-hour smoke pall, and at best were brown, drooped, dropped leaves, and had discolorated flowers. As early as three months after the smoke abatement program had been in operation, the beneficial effects on plant life were noticeable and in 1945 even evergreens and junipers could be grown in downtown St. Louis.

The maximum safe concentration of sulfur dioxide for plant life has not been defined too accurately. It appears to be about 0.25 or 0.30 ppm, but it is hard to define accurately because this pollutant is never present in approximately uniform concentrations continuously throughout the entire growing season[23]. Concentrations as high as 0.50 ppm for short exposures affect plants only temporarily. According to the information available at present, the average concentration of sulfur dioxide should not exceed 0.2 or 0.25 ppm throughout the growing season if adverse effects on vegetation are to be prevented.

The effect of atmospheric pollution on animals appears to be of two types (1) the direct effect of the pollutants on the animals, and (2) the indirect effect on certain animals from eating contaminated vegetation. Of these, the latter type seems to be of greater importance, evidence indicating a direct effect being very meager at present.

A number of cases have been reported in which animals — horses, cattle and sheep, are alleged to have been injured by feeding on grass and hay containing harmful amounts of substances brought in contact with the vegetation through air pollution[21]. Examples are (1) the injury to horses by lead poisoning in the fertile Jordan River Valley because of the lead contributed to the vegetation through air pollutants discharged by the smelter at Salt Lake City and (2) arsenical poisoning of horses, cattle and sheep feeding on hay and range grass contaminated with arsenic discharged by the smelter at Anaconda, Mont. In the latter instance the presence of arsenial ulcers in the nostrils of horses and sheep cannot be denied. The ulcers were produced by the arsenic dust released from the hay and grass while feeding. In another instance, the aluminum industry in the Pacific Northwest is being sued by farmers who content that fluorine fumes are injuring and killing their livestock, crops and trees[24].

AIR POLLUTION CONTROL

The discussion to this point has been devoted to

defining air pollution, its concentration, nature and effects. In the remainder of the paper will be discussed briefly some of the several aspects of its control. The word "briefly" is used advisedly because a thorough discussion of even one type of control equipment would require more time and space than has been alloted to this entire paper.

What has industry, and for that matter the railroads and other consumers of soft coal, been doing to alleviate the problems raised by atmospheric pollution? Have they been turning a deaf ear to this subject and defiantly ignoring the handwriting on the wall? The answer in some few instances must be in the affirmative. The money these industries were trying to save more than likely will be lost many times over in restoring friendly relations in the respective communities. In addition, the companies in the end have been or will be forced by regulation to do what they should have done in the first place.

Fortunately the picture for industry as a whole is much brighter. The amount of money being spent annually by industry to control atmospheric pollution is enormous. For example, 75 leading companies were contacted with respect to the annual capital outlay for dust, fume, mist, gas and smoke abatement equipment[25]. Of these, 25 preferred not to release figures but the other 50 companies, two-thirds of the total number contacted, agreed to disclose such expenditures. Because some of these firms have not separated their costs for atmospheric pollution control from those for stream pollution abatement, expenditures for both types of waste disposal were obtained for all 50 companies. These figures show that somewhat more than $35,000,000 were spent in the last two years and expenditures already planned for the next two years total about $32,500,000. If these companies are representative, industry as a whole is spending $200,000,000 to $300,000,000 annually for the elimination of water and air pollution. These estimated amounts are substantiated by W. B. Gibson of Stanford Research Institute who estimated that well over $100,000,000 net is being expended annually to control air pollution in this country[18].

There are other factors that dictate caution on the part of industry. For example, money spent for such purposes must usually be counted as capital investment rather than current expense. Unlike most capital investment, it frequently yields no increase in production, has no measurable monetary return. Yet because it increases the cost of the plant it will be reflected in the cost of the product which must either be absorbed by the industry or passed on to the consumer. In the final analysis, it will have to be met by everybody. In our complex civilization these charges will inevitably affect customers, employees, investors, the community and the public.

So much for a hurried picture of the general aspects of control. Let us turn now to the technical aspects, what are the engineering procedures that may be employed to abate air pollution. These will be considered under four classes, namely (1) substitution, (2) conversion, (3) retention and (4) dispersion. Of these, the last two are far more important than the others.

Substitution of a machine or material that produces or releases less polluting material is an effective procedure but very limited in scope. Examples are the substitution of diesel locomotives for coal-burning ones; the substitution of gas or fuel oil for heating domestic, public and other buildings; and substitution of low-volatile solid fuels for high-volatile ones such as bituminous coal having a volatile content of not more than 23 per cent for that having a higher volatile content; and the substitution of stoker-feed for manual-feed equipment. These changes alone have contributed remarkably to air pollution abatement in such places as St. Louis, Pittsburgh, Nashville and Cincinnati.

Conversion likewise is rather limited in scope. Examples are converting sulfur dioxide to sulfuric acid; converting the carbon monoxide in waste blast furnace gas to carbon dioxide by burning, and converting certain other carbonaceous solids and odorous and obnoxious gases to less obnoxious pollutants by burning.

By retention is meant the removal of a substantial percentage of pollutants from excessively contaminated air and gases discharged to the atmosphere through stacks and otherwise escaping to the atmosphere. It is for equipment of this kind, filtering or collecting equipment, that the bulk of the money will probably be spent. It is unfortunate that the collected materials in most instances have little if any monetary value making the capital outlay for such equipment almost a total direct economic loss.

It must be emphasized that it is exceedingly difficult to remove the very fine particulate matter or to remove the last vestige of any contaminant from an air stream. As with grades in school, the first 80 or 90 per cent is not difficult to obtain by comparison with the other 10 or 20 per cent. Our engineering know-how today in the field of air pollutant collection does not extend much beyond 95 and certainly not beyond 99 per cent. Removal of that last trace where such is necessary is beyond the reach of current practical technology and will require a large investment in research and development.

Since the fundamental principles and techniques involved in the removal of particulate matter are different from those in the removal of gaseous pollutants, let us consider each group separately. There is a large variety of collectors of different types on the market today. There is no best one nor worst one for all pollutants since all collectors have different characteristics with respect to size of contaminant, amount of very fine material, dust loading, temperature of fluid stream and nature of the contaminent. The selection of the best or even a satisfactory collector frequently requires knowledge about the contaminant possessed by few technical people in industry. Thus cyclones are being used where they cannot possibly be satisfactory because of particle size and precipitators are being used where they cannot be satisfactory because of dust loading.

Collectors for particulate contaminants may be divided into five main groups according to the mode of operation. These are, centrifugal collectors (including cyclones, rotoclones and multiclones), wet collectors, electric precipitators, fabric filters, and agglomerators. Possibly the last group does not properly belong in this category since agglomerators do not collect the material, they merely flocculate the very fine particles to produce

larger ones which in turn are easily removed by any of the other types of collectors[26]. Data useful in the selection of the proper type of collector for any given situation are summarized briefly in Table III[27].

TABLE III

Group	Particle-size range in microns against which collecting efficiency is 95-99 per cent by weight	Type of operations for which equipment is best suited
Centrifugal collectors		
Cyclones	20-500	Process exhaust systems
Rotoclones	20-500	Process exhaust systems
Multiclones	10-200	Fly ash and drying equipment
Wet collectors	2-100	Process exhaust systems
Electric precipitators	0.5-100	Fly ash and smoke
Fabric filters	0.2-20	All except oil or sticky materials
Agglomerators	0.01-2	Smoke

It is regrettable that this part of the subject matter cannot be developed in much greater detail, but such procedure would inevitably single out or point to specific equipment of obvious manufacture for comparison with others; a decidedly inadvisable thing to do in a paper of this kind. It is important, however, to point out that the data given in the table are of a general nature intended to be applicable to all equipment in the group. Recent advances in development of specific equipment in some of the groups indicates considerable improvement, possibly enough in certain instances to make the classification unfair[28,29]. It is well to bear in mind at all times when confronted with the selection of a collector for a given job that it is as illogical to install a centrifugal collector and possibly even a wet collector for the removal of a typical smoke as it is to install chicken-wire over the windows or your house to keep the mosquitoes out even though it would be fully effective against chickens.

The retention or removal of gaseous contaminants from air streams is difficult also, in many cases even more difficult than removing solid pollutants. Absorption towers are used rather extensively for this purpose. The construction of the tower may vary widely depending upon (1) the nature of the gas, (2) the temperature of the fluid stream, and (3) the percentage removal required. Almost any degree of removal can be obtained but the installation and operating costs frequently increase rapidly if high efficiencies are required. In general, gaseous contaminants are not removed from the discharged air as a common practice. They frequently do not present the air pollution problem that the solid contaminants do and where they must be controlled, dispersion from high stacks is often the method of choice.

Before leaving the subject of collectors, it is well to point to the growing need for research and development in this field. There is dire need for much more practical information that will permit the engineers in industry to select proper equipment or to determine in advance that the job in question requires a combination of collectors. Likewise, in my opinion, there is great need for the development of collecting equipment that is much less costly to install and/or to operate on most air pollution control problems than is available today. There is little doubt that there is enough engineering know-how and suitable equipment of various types available at present to bring any air pollution problem under control, if industry can stand the cost. It frequently has been stated that air pollution control is a matter of the three E's — Education, Engineering and Equipment. The truth of this statement cannot be challenged but the third E raises a serious question of economics.

The fourth method of controlling air pollutants is dispersion, i.e., reducing the concentration to an innocuous level by dilution or mixing in the atmosphere. This method is applicable to any type of pollutant, but it is more suitable for gaseous contaminants than for solid ones especially if the particle size is large. Much research has been done on the dispersion of smoke and gases from chimneys and has resulted in the development of equations, curves, and data from which the minimum stack height may be determined [30, 31, 32]. The information available illustrates rather convincingly that tall stacks have very beneficial effects in dispersing air contaminants from factories. The maximum ground concentration varies inversely with the square of stack height.

REGULATORY CONTROL OF AIR POLLUTION

The status of air pollution and its abatement at the moment is where stream pollution and abatement was along about 1940. Progress in air pollution abatement is and will continue to be much more rapid than it was in stream pollution control for obvious reasons. In this age of emphasis on social betterment and of official regulation of everything having to do with the well-being of the public, ordinances and laws regulating air pollution are being passed or revised at record rate by municipalities, counties, states and the federal government. This procedure is regarded with suspicion by many people, not so much because they oppose the passage of sound regulations as because they fear what may happen in any and all instances where the development of the regulation becomes a political item. Air pollution abatement including the drawing of regulations for it is strictly a technical matter in which there is no place for politics. Too frequently politics finds its way into the program with unhappy results. Often when air pollution control becomes a political issue, it works a hardship on those industries in the area which have already begun cleaning up, because to keep his political constituents happy the politician puts the pressure on all industry to reduce their pollutant output by some prescribed percentage. This procedure is decidedly advantageous to the industry that has done nothing, and is wholly unfair to the industry that has already reduced its pollution. This has even had a bad influence on some industries, since with this in mind, they wait purposely for the passage of the ordinance before doing anything so that they will not be at a disadvantage in reducing their smoke output on a percentage basis.

Happily for industry and for all who are honestly engaged in air pollution abatement, politics has not governed the content of the ordinances or laws in many instances to the extent that they have become absurd. Most regulations are written on a rather sound basis, the ASME bulletin serving as a guide in many instances[33]. Some of the typical stipulations in most laws may be summarized briefly somewhat as follows[15]:

1. Smoke discharge is regulated according to the density as determined by the Ringleman chart. Most cities prohibit greater density than No. 2 Ringleman but some set their limit at No. 3. The tendency today is toward No. 2.
2. Most regulatory laws include provisions permitting excessive smoke discharge for short periods of time. This usually takes the form of permitting the next higher Ringleman density to exist for a few minutes out of a prescribed number of minutes to permit cleaning fire boxes, starting fires, blast furnace slips and the like.
3. Where there are prohibitions to solid fuels, the volatile content is merely limited; usually not to exceed more than about 23 per cent.
4. Other solid contaminants are usually regulated in rather general terms, although some laws state specifically the maximum amount of solid per unit volume of stack gases that may be discharged. Los Angeles county has revised its rules to regulate the absolute quantity rate of discharge.
5. Noxious gases are usually regulated in very general terms, i.e., so as not to create a nuisance. Even sulfur dioxide, the most common gaseous pollutant, is almost entirely free of specific regulation.

Of interest is the fact that municipal waste burning is not covered in these ordinances. This is a source of considerable air pollution in many communities and was one of the important contributors of smoke to the Los Angeles county atmosphere until recently. Where meteorological inversions are common and create especially annoying conditions such as in the Los Angeles area, the regulations are being changed to decrease the permissible discharge rate since the pollutants are not dissipated effectively during the periods of inversion.

In closing, it is advisable to repeat several observations or opinions which are very important to the successful conduct of air pollution abatement.

1. It behooves industry everywhere to gather information by all practical means on the nature and amount of air pollutants it is discharging to the atmosphere and on the concentration of these pollutants in the area or neighborhood surrounding the plant and extending sufficiently far beyond it (especially on the leeward side with respect to the prevailing wind) to insure that nothing is being overlooked. With information of this kind at hand industry will be in an inestimably better position (1) to know what if anything is required in the way of control equipment, (2) to gain the confidence of the city fathers, technical experts or state officials when a complaint arises or the passing of a law is threatened, (3) to cooperate with and even guide the people who are to write the regulations, and (4) to defend itself if unjust claims or suits are instituted.

2. The amount of money involved in abating air pollution is so great that extensive research should be undertaken especially on the development of less expensive collecting equipment for removing solid pollutants from stack gases and contaminated air discharged by process ventilating systems. This is a logical project for some industry-wide association or associations to sponsor, such as the American Iron and Steel Institute with respect to the collection problems peculiar to or specific in the steel industry.

3. Air pollution abatement, like stream pollution abatement, is with us to stay. Let us face it not fight it, help wherever we can rather than hinder at every turn. We should proceed with caution, yes, but proceed, not stand firm. If you are creating excessive air pollution or discharging pollutants at a rate in excess of that specified in most laws, assume that sooner or later you will have to control it, so by doing it now it costs no more and you keep the goodwill of the community and of others concerned.

4. Do not keep your air pollution activity a secret. Let the community and the public know what you are doing and what it is going to cost in dollars and cents. The expenditure of sums of money of the magnitude required in air pollution control has a singularly sobering effect on the habitual growlers whose only other monetary association with the industry in question may well be the rosy financial reports of recent years.

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DISCUSSION

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L. F. Coffin: There is no question but that industry is going to be faced with this situation and should take steps to take the lead, and I feel confident that with Dr. Brandt in our midst progress will be made.

Your statement that more and more regulatory measures were coming into effect and that the state of air pollution control was about the same as stream pollution was in 1940, leads me to wonder whether you would be so bold as to attempt to predict any date in this country at which the proper level of air pollution might be reached. Dr. Brandt's statement that we should avoid secrecy is extremely important. I believe that it not only inspires confidence on the part of our employees, but also on the part of the public authorities to let everyone in the community know what is being done and to be frank about the facts.

N. H. Jensen: A few months ago we had an inspector at Lukens to investigate the air condition in our sodium hydride plant. The question of air pollution came up and he stated that in a few years we might have to take care of air pollution in a general way. I wonder if that time limit is correct or what you said about thirty years is more nearly correct, because if it is only a matter of a few years, we should begin to think very seriously about it.

J. M. Spencer: There is one phase of the pollution problem With which I am particularly acquainted, namely, fly-ash. You gave us an estimate as to the economic charges that could be attributed to the pollution problem, but with respect to the fly-ash problem I think there are other economic charges that are probably not realized. One important one, is the necessary "down rating" of very large plants simply because they have not been able to get along with their neighbors in the community and have been plagued with court suits.

Another important part of that program is the fact that if fly-ash exists, it is frequently a very difficult problem to control, and, in addition, there are probably millions of dollars spent by the utilities each year just for the maintenance of equipment because of that particular problem.

A. H. Arbogast: In discussing Dr. Brandt's paper, it seems to me that we of the steel industry should be the first to understand that our industry is a leading factor along with ragweed and goldenrod, in producing of nuisance dust and resulting air pollution. The general public has been slow to demand correction even though abatement has been sporadically enforced since the early dawn of our history. However, the present trend of both public sentiment and governmental intervention has been concentrated toward enforcement of nuisance-dust abatement measures. The reasons for this attitude toward air pollution abatement are closely related to those of stream pollution abatement, and have been grossly agitated and stimulated by the St. Louis and Pittsburgh statutes, and by the tragedy which occurred last winter in Donora, Pa.

It has been said by the sages of old, "Know thyself." In order to know ourselves in industry it requires study, not only with a Ringleman chart but in terms of actual grains per cubic foot of dust which is discharged with our stack gases. The results in terms of permissible nuisance dust are much easier to determine, understand and prevent than are the parallel pollutants of the natural streams. The tests for stack gases are relatively simple gravometric procedures of precipitation, and the information necessary for these procedures are available in the published literature of our society and other scientific and trade journals.

We may well appreciate and thank Dr. Brandt for his very able paper covering the discussion and analysis of these problems. It is not only up to industry in general, but to our steel industry in particular, to lead the way in "knowing itself" and providing for itself the necessary means and equipment for the abatement of these nuisances, just as we are leading the way in stream pollution abatement.

C. S. Cassels: Those of us who are situated in Philadelphia County know that our local government is taking increased interest in the smoke abatement problem and is now warning operators of observed violations. More stringent action is anticipated.

From the standpoint of the resident of areas adjacent to industrial sections, we are glad to see this activity. There is the general belief that smoke and dust, in addition to being a nuisance, is physically harmful although we do not know just what harm it does.

From the standpoint of the industries concerned, the program of smoke and fly-ash abatement presents several problems, primarily the technical and financial ones connected with the elimination of the discharge, and secondly, to those of us located in built up areas especially, the problem of the proper disposal of the fines after they are collected from our dust producing operations. While this latter phase has received no great consideration as yet, its importance is certain to increase as time goes on.

R. L. Willis: I believe, particularly in the case of the wet collectors and certain electric precipitators, that the material washed out may add to the stream pollution problem.

George Walz: Dr. Brandt has most ably and thoroughly discussed in his very interesting paper, from the viewpoint of hygiene, the decidedly injurious effects of air pollution on the health of human beings, animals and vegetation, but there is one very important by-product of his findings, which has not been mentioned here tonight, and that is, that when you take dust, especially metallic and magnetic particles, out of the atmosphere around a steel plant, you are definitely prolonging the life, and improving the operation of d-c commutators, a-c slip-rings, induction motors with small air-gaps, bearings, and many different types of electrical control apparatus.

We have one situation at our Steelton plant, where the commutators of a number of large d-c machines are being very adversely affected by what is probably the worst dust of all, sintered ore dust. This kind of dust has the abrasiveness and cutting qualities of a good grade of emery-powder, and is extremely hard on all wearing surfaces. I feel confident, that the more progress there is made in the matter of air purification, as Dr. Brandt advocates, the easier it is going to be for us electrical maintenance men to keep our equipment in good operating condition.

John S. Morris: You said that the coal-burning locomotives in the Pittsburgh area contributed considerably of the smoke around Pittsburgh and, if you used diesel locomotives that that smoke content would go down. I would like to ask you about the carbon monoxide which the diesels will give off. Also, what effect is there from the carbon monoxide given off by the automobiles we use around the streets of the cities, and how much that contributes toward killing vegetation?

Martin J. Conway: I want to first refer to the effect of smoke and dust inhaled by the operators some 50 years ago, with no apparent ill effects to their health. This may be partly due to the difference in tons per man-hour produced today compared with the production in the old days.

I agree with Dr. Brandt's intimation that we take the public into our confidence by telling them of our efforts in solving the problem of atmosphere pollution. I want to cite an instance I know about, in a steel plant in the middle western states. Two open hearth stacks had been chronic offenders and means were applied to clean them up. Approximately 90 per cent of the dust was taken from the waste gases, yet to the public eye the stacks released the waste gases having the same color as before the treatment had been applied. This also substantiates Dr. Brandt's statement that the last few per cent is the most difficult yet most important to eliminate.

Dr. Brandt mentioned that the sulphur dioxide content in the atmosphere was very low in Washington, D. C. whereas it was rather high in Wheeling, W. Va. This is no doubt due to the fact that the number of industrial plants in Washington is small and natural gas is the predominant fuel, and in Wheeling, the district is crowded with industry and bituminous coal is the chief fuel.

If Dr. Brandt has any information on the quantity of dust released to the atmosphere by the average open hearth furnace, I will appreciate having this information, say, in grains per cubic foot of gas and if available, information on the iron oxide content in the dust from an open hearth stack?

H. Spiess: Dr. Brandt has given the steel plant engineer food for thought in his presentation of problems of air pollution. Ten years ago we were hearing similar papers on stream pollution, and now we are in the midst of the program of cleaning our streams and rivers.

I have a question that I would like to ask Dr. Brandt, regarding a dust problem. This dust settles in the early morning but is not the color you would expect from a steel mill. It is at present quite annoying to the residents of a near by town in that a white deposite sticks to houses, automobiles and etc. The question is: What manner of positive proof of pollution by any designated industry is required by law before legal action can be taken by the person or community being subjected to this condition?

Allen D. Brandt: In answer to Mr. Coffin's question, whether I would hazard a guess as to when we will reach a satisfactory level of atmospheric pollution, I might say that I do not have any positive idea on this, but it seems to me that it is not going to happen in a hurry because the expenditure is too great, for one thing, and there is too little available in the way of engineering know-how to remove these contaminants at a cost that industry can stand. I question whether it is economically feasible to do it with the equipment available today. Again, I would like to plead for a good research program sponsored by some appropriate organization to develop collecting equipment which is a lot cheaper. I am sure it can be done. In answer to the question, however, in the light of present knowledge with respect to what are satisfactory levels, and with the rate of progress now evident in controlling pollutants, it is my guess that ten to twenty years will see us close to satisfactory levels. The only reason we are in the present situation is that our production has mushroomed, has gone up rapidly, while the control measures lag behind.

Mr. Jensen questioned when we expect to have a law in Pennsylvania that will require the control of atmospheric pollution. As he probably knows, the State of Pennsylvania passed a law a short time ago creating a Division of Atmospheric Pollution Control in the Health Department. That law became effective very recently. Personnel and equipment are being obtained to work on this very thing, to do air-sampling throughout the State, checking concentrations in the stacks, and so on. Probably you will be visited by representatives of this division in the not-too-distant future.

In addition, there was created in the City of Philadelphia an Air Pollution Control Commission or Board. Mr. Hodges is the man in charge. Therefore, those of you who have operations within the city limits can look to this new agency for assistance. Maybe Mr. Hodges or his men have already called on you for information, because at the moment they do not have much information as to the nature of the contaminants, or what the stack concentrations are, since they have little background data other than that summarized in the literature.

Mr. Spencer, of Bethlehem Steel Co.'s Sparrow Point plant, suggested several other fly-ash problems. I am grateful to him for this. The subject of air pollution in all its phases is a very big one. To mention or discuss all things that might have been included in this report would have required volumes rather than a short paper. But there are many other problems connected not only with fly-ash, but with mists, vapors and gases that are discharged by ventilating systems. I would like to have given a much more complete background if time had permitted, rather than merely to skim the surface.

Mr. Cassels pointed to the problem of atmospheric waste disposal. That is a very good point. You certainly cannot discharge the water from wet collectors into the streams indiscriminately. This means including some water cleaning equipment as part of the dust collection installation. What to do with the collected material is a problem. Research is going on with respect to the sale or marketing of some of these materials. The market usually is not good, but sometimes it will pay about enough for the cost of collection. I do not mean the cost of installing equipment, but rather taking the material out of the collector and putting it in a railroad car or on a truck. Occasionally, of course, valuable products are recovered. Unfortunately this is the exception rather than the rule. Mr. Morrow sent me a clipping which pointed out that at one of the Chicago power plants they were taking the fly-ash collected by their units and selling it to a construction company in the far west where it is being used in part as a substitute for cement in the building of a large dam. So there are some markets. Many times they are difficult to find, but conditions in this respect will probably improve as time goes on. Some must be dumped as other wastes are. This is a matter of finding a suitable spot, the same as for dumping garbage or slag.

Mr. Willis raised the question of getting rid of material from wet collectors and precipitators. I believe I have answered that. You cannot run it into nearby streams in most cases.

Mr. Walz introduced the subject of the reduction in maintenance costs if the polluting material is taken out of the air. I can mention a number of places where the pollutant presents a serious maintenance problem to nearby equipment. For example, in sand-blasting ships in repair yards to remove the paint from the hull prior to repainting, the sand fines carry a considerable distance. Even though the motors are frequently covered with tarpaulins, the sand occasionally gets into the bearings. Even within a given plant you will sometimes find that high-class machinery must be moved to a relatively dust-free area so that it can be maintained in satisfactory operating condition.

Mr. Morris asked what about the carbon monoxide from diesels and automobiles and its effect on vegetation. Carbon monoxide in the concentrations normally produced by diesels or automobiles is not a problem with respect to vegetation. It could be with human beings. Diesels produce very little carbon monoxide. In fact, automobiles produce much more. Studies of the carbon monoxide concentrations in the streets have been made in Baltimore, Philadelphia and other cities. Some of the individual concentrations were above the safe limit for 8-hours continuous exposure, but the average values were below the threshold limit. A study has also been made on the traffic officers at the entrances to the Holland Tunnel. Carbon monoxide concentrations in their blood were not excessive. Consequently the carbon monoxide from these sources is apparently not an important problem.

Mr. Conway pointed out that the concentration of sulfur dioxide is much greater in Wheeling, W. Va., than in Washington, D. C. The reasons are that little or no soft coal is burned in Washington and the country is relatively flat so that (1) the quantity of contaminant produced in Washington is less than in Wheeling, and (2) it does not accumulate as it does in some of the valleys around Wheeling.

He asked whether or not I could give him some idea about the specific quantities of material in the gas from open hearth stacks, and the iron oxide content. I do not have this information at my finger tips, but I know that Mr. Arbogast does, and as soon as I finish answering the other questions, he might reply to that.

Mr. Spiess asked what proof is necessary as to the type of material involved or the degree of atmospheric pollution present before legal action can be taken. Sometimes you do not need any proof except that a group of citizens may get together and consult a lawyer who carries on from there. However, if you want to have scientific data, the Air Pollution Control Division of the Health Department here in Pennsylvania could and probably would develop it for you. They will conduct a survey similar to the one carried out at Donora and measure concentrations of the pollutants in the air in the area in question, and by chemical and spectrographic analysis determine what is in the air. From these data and knowledge of the processes in nearby plants, the stacks responsible for the trouble can usually be isolated.

A. H. Arbogast: In the determinations we have made the dust content ranges from 0.20 grains per cubic foot to 0.65 grains per cubic foot in the open hearth stack, although the content may run as high as 3 grains per cubic foot. Of course wide variations occur, depending on the condition of the heat during the time of sampling. The analysis may run from 10 to 60 per cent iron oxide, together with various other metallic and non-metallic oxides.

CONTROLLED COOLING OF STEEL BLOOMS

in Car Bottom Furnaces

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MR. BURCH

. . . . a proposed method for handling blooms into car bottom furnaces for controlled cooling after rolling is described in this paper . . . . blooms can be charged into furnace before temperature of any bloom falls below 600 F . . . .

▲ IT is the purpose of this paper to present a description of proposed bloom handling facilities for the controlled cooling of steel blooms in car bottom furnaces. The advantages of controlled cooling processes over slow cooling and the factors governing the selection of the car bottom furnace, will first be discussed.

SLOW COOLING, THE COMMON FLAKE PREVENTION TREATMENT

If some types of high carbon or alloy steel blooms or billets are permitted to air cool to atmospheric temperature after they are rolled, fine cracks, generally described as "flaking," will develop throughout the center portion of the piece which may render the steel unfit for its intended use.

A heat treatment, involving slow cooling of the hot rolled product, is commonly employed for the control of flaking. One such process involves placing the hot steel into covered refractory pits or in covered, insulated gondola cars before its temperature has fallen below the transformation temperature. The blooms or billets are then allowed to cool slowly to 300 or 200 F, during which time the transformation takes place before removal for further processing. Steels such as SAE 3312 or SAE 4340, which are extremely deep hardening types, must be slow cooled in slag or ashes to retard the cooling rate sufficiently to produce the desired results.

The results produced by these slow cooling methods are not entirely dependable because of physical conditions and the lack of temperature control. Consequently, some flaking may occur and the accompanying surface cracking and hard spots may result in excessive conditioning costs. In some cases, the entire heat may have to be diverted and delivery thereby delayed.

The time-consuming feature of the slow cooling process is also a matter of much dissatisfaction from a production and delivery standpoint. The cooling time may be from eight to twelve days depending upon the size of the bloom. The only possible means of improving delivery time when such slow cooling facilities must be used, is to expedite the orders through the plant or to maintain a large stock of blooms and billets from which orders may be drawn.

CONTROLLED COOLING METHOD

The use of fired pits or furnaces for the cooling process, instead of the slow cooling facilities described above, presents a positive solution to the flaking problem and is referred to as "controlled cooling." Actually, it is a cycle annealing treatment of which there are two general types.

For grades such as SAE 4140, SAE 4150 and SAE 52100, the steel is equalized at 1200 F, held at that temperature until the transformation is complete, and

then removed from the furnace to cool. The time of this process is only 18 hours as compared to 72 hours for the slow cooling process.

Another general cycle is for the deep hardening grades such as SAE 3312 and SAE 4340. The temperature for these grades is equalized at 600 F where transformation is comparatively rapid. After transformation, the steel is softened by reheating to just below the equilibrium critical temperature. This controlled cooling cycle requires only 30 hours as compared to 120 hours for slow cooling similar steels.

Controlled cooling constitutes a type of treatment which produces the most desirable grain structure for further bloom processing operations. The uniform quality of the product eliminates excessive testing which permits early scheduling of the secondary mills and results in a reduction of mill delays. Conditioning time and costs are reduced and chipping is possible where grinding would frequently be necessary. Not only is the production of top quality steel made possible, but the reduction of cooling time by as much as 75 per cent expedites delivery of the finished product.

FACILITIES FOR CONTROLLED COOLING OF BLOOMS

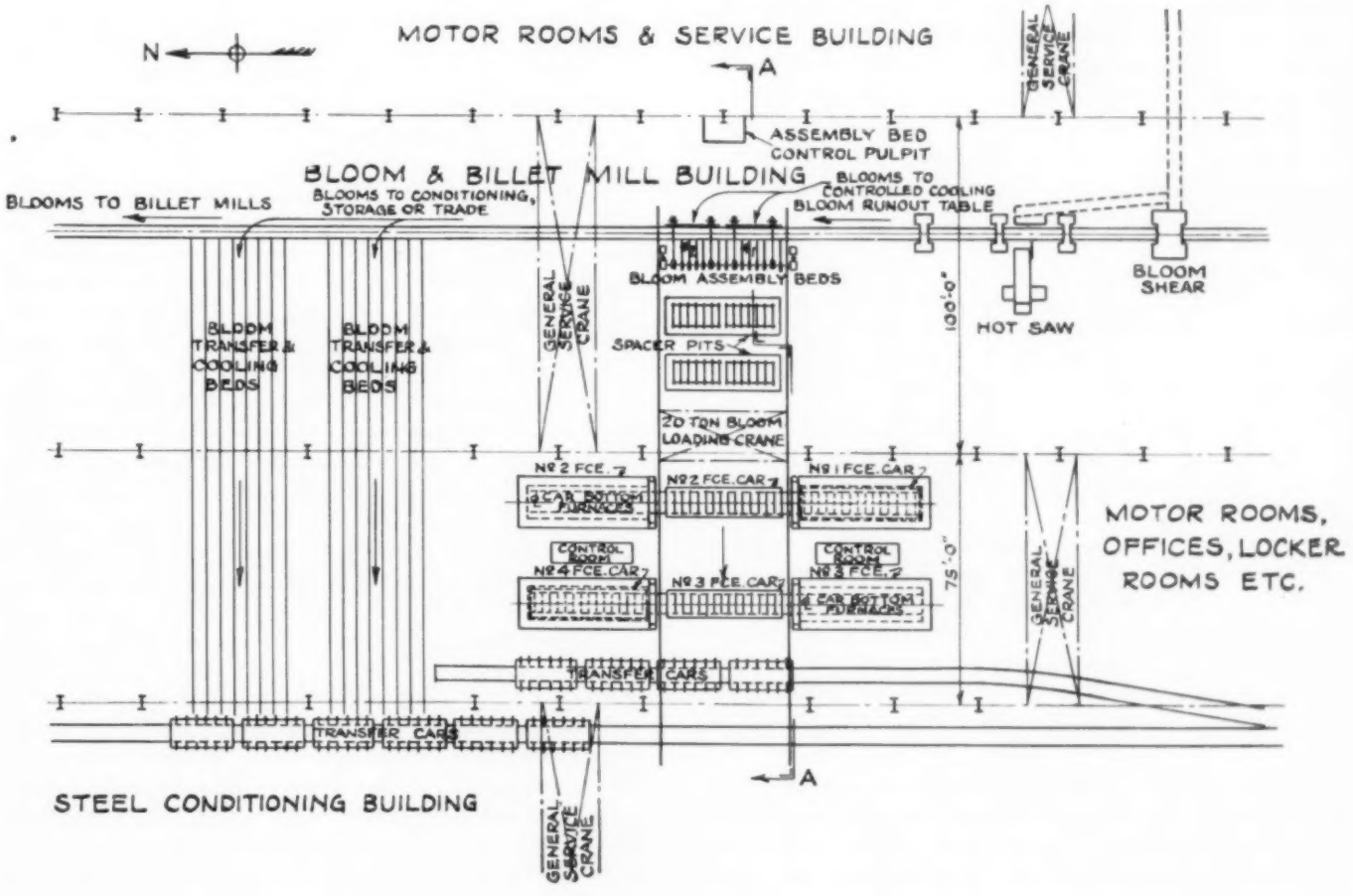
The development of the necessary facilities for the controlled cooling of blooms was begun by analyzing furnace requirements, including first cost and maintenance, flexibility of operation, adaptability to spacing of the load, and adaptability to material handling possibilities. With the type, capacity and dimensions of the furnace determined, the factors involved in delivering the blooms to and from the furnace were considered in an effort to devise handling facilities that would be as flexible, efficient and trouble-free as possible.

The types of furnaces which are capable of being used for controlled cooling cycles, are the pit furnace, the bell type furnace and the car bottom furnace. Of these furnaces, the pit type is most commonly used and, in many applications other than for the treatment of blooms and billets, has given complete satisfaction. The trend for the treatment of blooms and billets however, is toward the car bottom furnace.

THE CAR BOTTOM FURNACE

The chief advantage of the car bottom furnace is its flexibility of operation. For the types of steel requiring controlled cooling, the furnace loading must be completed before the coolest blooms reach a temperature of 600 F. However, possible interruptions in the delivery of steel caused by delays on the mill or breaks in rolling schedules, make necessary some provision for maintaining the minimum temperature of the blooms until the full charge is assembled. In the car bottom furnace, the load may be rapidly moved into and out of the furnace as desired. In the pit furnace such contingency may be provided for by placing the cover, but this operation

Figure 1 — Proposed plan of controlled cooling facilities of 110,000 net tons annual capacity.



requires the use of a crane. The bell type furnace is definitely unsuited in this respect. A 30 to 50-ton crane may be required to place the cover, the handling of which ultimately results in higher cover maintenance. Involved also is connection of fans, motors, gas and air piping and thermocouples. It is apparent that the cost of placing the bell and removing it as required for the purpose of temporarily holding the temperature of a load being assembled would be excessive.

Controlled cooling requires that the material subject to treatment be uniformly heated and cooled. It is, therefore, imperative that the blooms be separated in layers to permit the passage of hot gases or cooling air around each bloom contained in the load. The spacing problem is complicated by the fact that the steel assembled for controlled cooling is hot, which makes it impossible for a man to remain near the load for more than a few seconds. Spacing blooms as they are loaded into pits is complicated by the ascending heat, the necessary use of long bars to manipulate chains or spacers, and by the danger of operators falling into the pits. As for the car bottom and bell type furnaces, the weight and temperature of the spacers and increasing height of the furnace load makes the manual placing of spacers impossible. The placement of individual spacer bars by crane is likewise out of the question since spacing by this means could not be performed rapidly enough to keep up with the mill. Because of conditions stated above, a separated charge can best be prepared on a flat, open surface. This fact renders the pit type furnace the least desirable in this respect. Insofar as accessibility for loading is concerned, the bell type and car bottom furnaces are equal, but, as will be shown below, the car bottom furnace presents additional advantages. It becomes apparent however, that special handling facilities are required for satisfactory spacing of the blooms for the controlled cooling process, regardless of the type of furnace considered.

The arrangement of pit or bell type furnaces in line or in a rectangular pattern demands that the material handling facilities serve a relatively large area. However, car bottom furnaces may be arranged in a double line, in which case the intervening area required for the withdrawn car serves two furnaces. With this arrangement, the charge is delivered to half the number of furnace loading stations otherwise necessary. It follows therefore, that material may be delivered to car bottom furnaces in the least time and with a minimum of equipment.

The initial cost of the car bottom furnace is estimated to be 25 to 30 per cent higher than the bell type furnace, and approximately 15 per cent higher than the pit type furnace. However, the maintenance of the car bottom furnace is estimated to be about one fourth that required for the bell type and pit furnaces. As for auxiliary equipment cost, the handling of blooms to and from car bottom furnace may be accomplished with a small 20-ton crane whereas the bell type may require the service of a crane having a capacity as high as 50 tons.

The controlled cooling furnace must accommodate either half or the whole tonnage of blooms produced by an open hearth heat, to result in favorable loading and heating efficiency. An 80 per cent blooming mill yield from a 125-ton open hearth heat would require the use of a 100-ton capacity controlled cooling furnace. The number of such furnaces required for controlled cooling at 110,000 net ton annually, based upon a 24-hour average control cool cycle and 75 per cent furnace availability, is four furnaces.

HANDLING FACILITY REQUIREMENTS

Having decided upon the car bottom furnace as the best suited for the process, each of several general requirements must be given consideration if the development of a smooth functioning material handling unit is to be assured. The fundamental problem is that of conveying blooms of various sections and lengths from the mill runout table to the furnace where the load is made up in spaced layers. As previously mentioned, the loading must be performed at a rate as fast as or preferably faster, than the steel can be rolled. Another time limit consideration is that of having the load charged into the furnace before the temperature of any part has dropped below 600 F. Ordinarily, this limitation allows two hours' time to assemble a full furnace load of five inch square blooms and a longer time for blooms of larger section. For best efficiency operationwise, the design must be flexible, permitting limited rehandling if necessary, and the loading should be performed with a minimum number of operations. Costwise, efficiency may be achieved by a design embodying good principles of material flow both within the controlled cooling unit itself and as a part of the mill layout. A design which will require a minimum of maintenance will also contribute to this efficiency. The final consideration for the design of the material handling equipment, is that of safety of operation. In this respect, it must afford safe working conditions for the operators and be accident-proof with regard to damage to the equipment itself.

The general arrangement of the equipment used in the proposed controlled cooling facilities is shown in plan view, Figure 1, and in elevation, Figure 2. It consists of two bloom assembly beds, a furnace loading and unloading crane, one "C" hook spreader beam for blooms up to 16 ft long, one "C" hook spreader beam for blooms up to 32 ft long, 12 spacer units per furnace, one spacer unit lifting tongs and one spacer unit storage pit for each two furnaces.

Assembly beds — The purpose of the assembly beds is to collect the blooms as they are rolled to form them into a single layer pack preparatory to transfer by crane and "C" hooks to the furnace car bottom. The pack measuring 3 ft-0 in. wide by 16 ft-0 in. long, equal to one quarter of one layer which the car will accommodate, was selected as the maximum size load that could be handled by "C" hooks of reasonable proportions. Ordinarily then, four such packs are required to cover the furnace car area and constitute one layer of blooms. The number of layers per car required to make up a 100-ton capacity load, depends upon both the dimension of the bloom section in question, and how compactly the blooms may be loaded on the car. The runout table rollers and the assembly bed skids are spaced on 2 ft-3 in. centers and otherwise designed to accommodate blooms measuring 5 × 5 in. to 10 × 11½ in. in

cross-section, and from 5 ft-0 in. to 32 ft-0 in. in length. Each of the beds is equipped with a drag beam which may be operated singly for blooms up to 16 ft long or in unison for assembly of longer blooms. This arrangement also permits the assembly of a pack of blooms on either bed. The runout table rollers opposite the assembly beds are skewed six degrees to force the blooms against the drag beams, and thus eliminate the possibility of the blooms fouling on the bed skids. This portion of the runout table is divided into two sections which may be operated separately or together. The assemblying operations are all controlled from a pulpit opposite the assembly beds and several feet above them to provide the operator with a clear view of the beds and other furnace loading operations.

Furnace loading and unloading crane — The furnace is loaded and unloaded by a 20-ton capacity overhead traveling crane. The runway 19 ft above the floor, is transverse to the buildings, making possible the transfer of blooms from the mill runout table to the controlled cooling furnaces and from the furnaces to the steel conditioning building.

The bridge travel speed of this crane is specified at 200 fpm and its trolley travel speed is specified at 300 fpm. Two 10-ton main hoists which carry the "C" hooks have a full load speed of 50 fpm. The hoists have two drums each, to provide for hook attachment to the four corners of the "C" hook spreader. This four point suspension completely stabilizes the load regardless of the location of its center of gravity. The main hoists may be operated simultaneously for raising or lowering the load or the rear hoist may be operated independently to discharge the controlled cooled blooms on the transfer cars for subsequent distribution in the conditioning building.

An auxiliary hoist is provided for handling the spacer units. Two drums on this hoist provide attachment at each end of the spacer unit lifting tongs. The capacity of the hoist is 5 tons and a full load hoisting speed of 50 fpm is specified.

"C" Hook spreader beam — An end view of the "C" hook spreader beams is shown in Figure 2. A seven hook spreader with hooks spaced at 2 ft-3 in. centers is used to lift blooms ranging from five to sixteen feet long. A 6-hook spreader with hooks spaced at 4 ft-6 in. centers is used to lift blooms ranging from sixteen feet six in. to thirty-two feet long. The spacing of the hooks on equal and double the center distances of the assembly bed skids, the furnace load supports, and the spacer bars in the spacer unit permits lifting the blooms from or depositing them at these stations as desired.

Spacer unit — The design of the spacer unit shown in Figure 3 is based upon three principal requirements. First, the spaced blooms must be supported at intervals close enough to eliminate the possibility of the blooms sagging and bending during the furnace heating cycle. Second, the spacing must be done without delaying the loading operations to the extent that furnace loading cannot keep up with the mill production. Third, the spacer material must be heat resistant so that high physical strength would be maintained at furnace temperature approaching 1700 F, and the material must also resist oxidation to reduce scaling to a minimum. To provide for these requirements, a spacer unit was

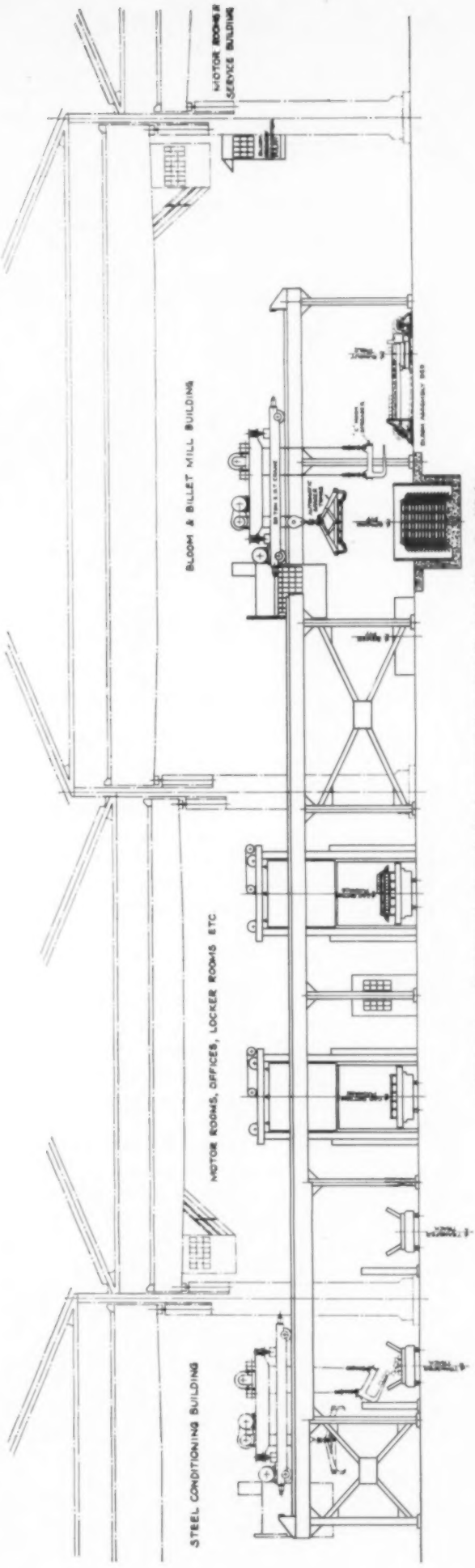
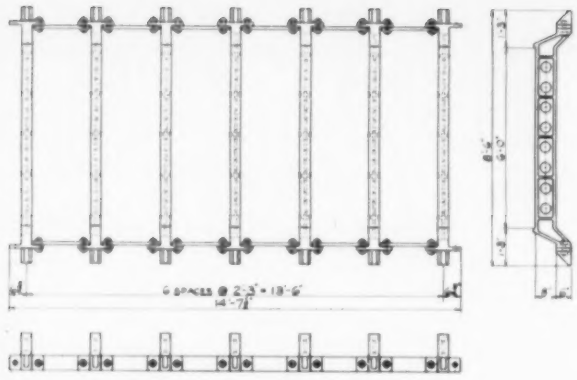
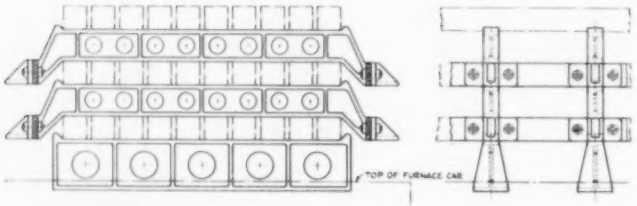

MOTOR ROOMS & SERVICE BUILDING
BLOOM & BILLET MILL BUILDING
MOTOR ROOMS, OFFICES, LOCKER ROOMS ETC
STEEL CONDITIONING BUILDING

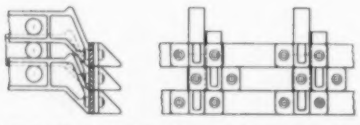
Figure 2 — Sectional view A-A of proposed controlled cooling facilities.



SPACER UNIT



ARRANGEMENT OF SPACER UNITS WITH FURNACE LOAD



ARRANGEMENT OF STACKING SPACER UNITS IN STORAGE PIT

Figure 3 — The drawing shows the arrangement of the spacer units.

developed of sufficient size to cover half of the furnace car. The tie links hinge from spacer bar to spacer bar to a limited degree so that the spacers may be lifted as a unit for rapid placing and still maintain the condition where all bending and compression stresses are carried by the spacer bars only.

The spacer bars are formed at each end to lower the tie links and permit the insertion of the "C" hooks in the openings between the spaced blooms and to allow free passage of gases between bloom layers. The arrangement of spacer units with the furnace load shown in Figure 3, illustrates how the shape of the spacer bars limits the width of the load and also keys the bloom layers together.

A heat resisting chromium nickel steel such as 25-12 is recommended as suitable material to be used throughout in the construction of the spacer units. The cost of this alloy is approximately ten times as much as medium carbon steel. However, it is expected that the high strength of chrome nickel steel at elevated temperatures (1400 to 1700 F), and its resistance to oxidation, are qualities which will eliminate high repair and replacement costs and operational difficulties certain to be encountered in the use of carbon steel. The early failure of carbon steel will also result in bent blooms and the straightening operations thereby necessitated would add to production costs. The heat resisting alloy spacers are expected to meet all service requirements and be most economical in every respect

Spacer unit lifting tongs — With one man operating the assembly beds and another operating the bloom transfer crane, it is apparent that the hitching of the spacer unit will have to be accomplished by automatic means. To accomplish this result, seven lifting lugs are provided on each side of the spacer units to be engaged by specially designed automatic tongs as shown in Figure 4. These tongs are carried at all times on the auxiliary hoist. To move the spacer units from the spacer pit to the furnace car, or from the furnace car to the spacer pit as required, the open tongs are lowered over the spacer unit so that contact with the unit forces the tongs open still farther. This movement of opening the tongs releases a "hold-open" latch so that when the tongs are subsequently raised by the crane, the tongs close on the unit and engage the lifting lugs. In placing the spacer unit on the furnace car or in the spacer pit, the tongs are lowered farther than necessary to bring the unit to rest, and in so doing, the "hold-open" latch is again engaged and the tongs are held open, enabling the crane operator to lift the tongs free of the spacer unit.

Spacer unit storage pit — Twelve spacer units are required to space a capacity load of 5 × 5-in. blooms in a single furnace. Storage is provided for 26 units (the number required for two furnaces plus two spares) in each pit located between the assembly beds and the furnace as shown n F gures 1 and 2. The spacer units are nested in a manner which stores them in a minimum of space as shown in Figure 3. It will be observed how a saw tooth arrangement of lifting lugs is formed in such a manner that the top unit can be engaged by the lifting tongs as shown in Figure 4.

CAR BOTTOM FURNACE LOADING PROCEDURE

The following description explains the furnace loading procedure and supplements the procedure outlined in Table I, which is tabulated as a loading schedule for operation of the bloom loading equipment:

Step 1 — As sheared blooms of like section are received from the mill for loading on the furnace car bottom, they are positioned opposite No. 1 assembly bed (Figure 1) and individually moved to the table side of the bed by drag beam in such a manner as to form a line of 1, 2 or 3 blooms depending upon the length of blooms being handled. As the last bloom is moved into line, all the blooms in that line are moved by drag beam to the furnace side of the bed where the pack is formed.

Step 1*a* — An alternate of the procedure described in Step 1 is that of collecting 2 or 3 blooms end to end before moving them to the bed for formation of the pack. This is accomplished by use of a bloom stop on the table or by running the table opposite the assembly bed slowly enough to allow the second bloom to overtake the first bloom, and the third bloom to overtake the second bloom. The line of blooms thus formed is moved to the assembly bed at one time. This alternate procedure may be used to advantage when the combined length of blooms is approximately 16 ft-0 in. long, and end to end spacing is not required to uniformly distribute the load.

Step 2 — The procedure of Step 1 or 1a is followed until a pack is formed which ordinarily will measure 16 ft-0 in. long and 3 ft-0 in. wide. Voids will occur in the pack when the above overall dimensions are not

TABLE I

CAR BOTTOM FURNACE LOADING PROCEDURE AS GOVERNED BY BLOOM LENGTH (BLOOM SECTION CONSTANT FOR EACH LAYER OF BLOOMS) EACH PACK 16 FT.-0 IN. LONG X 3 FT.-0 IN. WIDE — FOUR PACKS PER CAR LAYER

Bloom length, Ft-in.	Furnace car loading procedure for each layer of blooms				Loading efficiency based upon 192 sq ft available car area. Per cent	Length of "C" hook spreader. Ft-in.
	No. of blooms placed end to end per length of pack. Pack 1 and 2	Spacer unit	No. of blooms placed end to end per length of pack. Pack 3 and 4	Spacer unit		
5-0	3	Place 1	3	Place 1	78	14-0
5-6	3	Place 1	2 *15	Place 1	72	14-0
6-0	3	Place 1	2 *14	Place 1	78	14-0
6-6	2 *16	Place 1	2 *16	Place 1	68	14-0
7-0	2 *16	Place 1	2 *16	Place 1	73	14-0
7-6	2 *16	Place 1	2 *16	Place 1	78	14-0
8-0	2	Place 1	2	Place 1	83	14-0
8-3	2	Place 1	1 *15	Place 1	65	14-0
8-6	2	Place 1	1 *15	Place 1	66	14-0
9-0	2	Place 1	1 *14	Place 1	70	14-0
9-6	1 *13	.....	2	Place 2	74	14-0
10-0	1 *12	.....	2	Place 2	78	14-0
10-6	1 *11	.....	2	Place 2	82	14-0
10-8	1	.....	2	Place 2	83	14-0
11-0	1 *16	Place 1	1 *16	Place 1	57	14-0
11-6	1 *16	Place 1	1 *16	Place 1	60	14-0
12-0	1 *16	Place 1	1 *16	Place 1	63	14-0
12-6	1 *16	Place 1	1 *16	Place 1	65	14-0
13-0	1 *16	Place 1	1 *16	Place 1	68	14-0
13-6	1 *16	Place 1	1 *16	Place 1	70	14-0
14-0	1 *16	Place 1	1 *16	Place 1	73	14-0
14-6	1 *16	Place 1	1 *16	Place 1	76	14-0
15-0	1 *16	Place 1	1 *16	Place 1	78	14-0
15-6	1	Place 1	1	Place 1	81	14-0
16-0	1	Place 1	1	Place 1	83	14-0
16-6	1	Place 1	1	Place 1	86	23-0
17-0	1 *32	Place 2	.....	.....	44	23-0
18-0	1 *32	Place 2	.....	.....	47	23-0
19-0	1 *32	Place 2	.....	.....	50	23-0
20-0	1 *32	Place 2	.....	.....	52	23-0
21-0	1 *32	Place 2	.....	.....	55	23-0
22-0	1 *32	Place 2	.....	.....	57	23-0
23-0	1 *32	Place 2	.....	.....	60	23-0
24-0	1 *32	Place 2	.....	.....	62	23-0
25-0	1 *32	Place 2	.....	.....	65	23-0
26-0	1 *32	Place 2	.....	.....	68	23-0
27-0	1 *32	Place 2	.....	.....	70	23-0
28-0	1 *32	Place 2	.....	.....	73	23-0
29-0	1 *32	Place 2	.....	.....	75	23-0
30-0	1 *32	Place 2	.....	.....	78	23-0
31-0	1 *32	Place 2	.....	.....	81	23-0
32-0	1 *32	Place 2	.....	.....	83	23-0

2 *15 — Indicates 2 blooms end to end staggered to form pack having overall length of 15 ft-0 in. Briefly, 2 blooms staggered to 15 ft-0 in.

Bloom section, in.	Maximum No. of blooms side by side per width of pack	
	Pack 1 and 3	Pack 2 and 4
5 x 5	6	6
5½ x 5½	6	6
6 x 6	5	5
6½ x 6½	5	5
7 x 7	4	5
7½ x 7½	4	4
8 x 8	4	4
8½ x 8½	3	4
9 x 9	3	4
9½ x 9½	3	3
10 x 10	3	3
10 x 11½	2	3

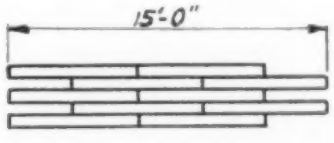


Illustration of staggered blooms

Pack 3	Pack 1
Pack 4	Pack 2

Pack location on furnace car looking east (Figure 1)

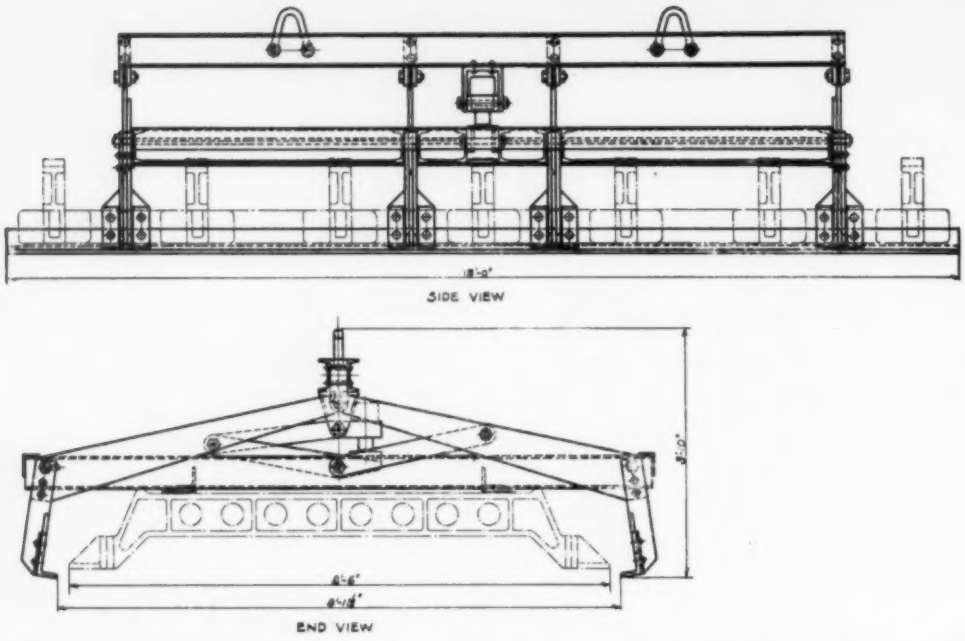


Figure 4 — A specially designed automatic tong is used with the spacer unit.

multiples of the bloom lengths or sections, and staggering and spacing of the blooms is necessary.

Step 3 — The bloom pack thus formed is lifted by a spreader of seven "C" hooks and moved by overhead crane to occupy approximately one-half the width and one-half the length of the furnace car.

Step 4 — On the return for the next pack, the crane operator using the special tongs on the auxiliary hoist picks up a spacer unit from the storage pit between the assembly beds and the furnaces.

Step 5 — A similar pack large enough to cover one quarter of the furnace car is made up on No. 1 assembly bed and in like manner deposited beside the first pack, thus completing the covering of approximately one-half the furnace car with one layer of steel.

Step 6 — The crane now lowers a unit of spacers on top of the layer of steel just placed on the car. It is important that each spacer bar rest on the load and be located directly above its corresponding furnace load support.

Step 7 — The above procedure is followed in loading the remaining half of the car. At this time it may be found convenient to assemble the bloom packs on No. 2 assembly bed.

Step 8 — A spacer unit is then placed on the blooms loaded on the remaining half of the furnace car as described in Step 6 in preparation for the second full layer of steel.

The car loading proceeds by cycles of two packs and one spacer unit, two packs and one spacer unit, for each full layer of steel for all bloom lengths from 5 ft-0 in. to 9 ft-0 in. inclusive. In every case, the pack formed must be long enough to rest upon every spacer bar below, so that support is provided to every spacer bar placed above.

When bloom lengths are from 9 ft-6 in. to 10 ft-8 in. inclusive, the furnace car loading is accomplished with the use of the seven hook spreader and proceeds by cycles of four packs and two spacer units for each full layer of steel (see Table I).

When bloom lengths are from 11 ft-0 in. to 16 ft-0 in. inclusive, the furnace car loading is again accomplished with the use of the seven hook spreader and proceeds by cycles of two packs and one spacer unit, two packs and one spacer unit for each full layer of steel (see Table I).

When bloom lengths are from 16 ft-6 in. to 32 ft-0 in. inclusive, the furnace car loading is accomplished with the use of a six hook spreader 23 ft-0 in. long and proceeds by cycles of two 32 ft-0 in. long packs and two spacer units for each full layer of steel (see Table I).

Variations in the above procedure may be desirable and necessary depending upon the sequence in which the various sizes and lengths of blooms are received at the loading table. Some of the possible variations are as follows:

1. Long and short lengths of blooms may alternate in a definite pattern which allows lining the short blooms up with the long ones rather than staggering the long blooms. If the 23 ft-0 in. long "C" hook spreader is used, the shortest bloom handled should not be less than 10 ft long.
2. Long and short lengths of blooms may alternate, requiring the assembly of a pack of long lengths on one bed simultaneously with the assembly of a pack of short blooms on the second bed. As the packs (measuring 16 ft-0 in. long × 3 ft-0 in. wide) are completed, they are loaded on the furnace car bottom.
3. When a change of bloom section occurs and three or four blooms in excess of the last full layer are to be charged, it may be desirable to hold them at some point on the runout table or on an unused assembly bed, and later place them as part of the top layer of the furnace load. Obviously, the variation in section of the top layer blooms need not be restricted.
4. When a change of bloom section occurs and approximately half the number of blooms required for a full car layer are in excess of the last full layer placed, they may be loaded by packing alternate large and small sections side by side. In this case, care should be taken to locate the largest bloom sections on the outside edges of the layer so that the extreme ends of the spacer bars will be supported.

5. When a change of bloom section occurs and approximately half the number of blooms required for a full car layer are in excess of the last full layer placed, they may be spaced side by side over the car area at not less than one foot intervals. In this case, as in every other case, the overall width of the full car layer should be 6 ft-0 in. and the packs formed must be long enough to rest upon and support every spacer bar. It is apparent that because of the low loading efficiency of this method, it should be used only when there is sufficient space remaining to receive the full heat of steel to be controlled cooled.
6. Should one or more blooms be moved to an assembly bed or to the furnace car bottom and a change of loading procedure is unexpectedly required, the blooms should be returned to the runout table for redistribution on the furnace car. The blooms may be returned to the runout table in the following manner. With the drag beam of one of the two assembly tables pulled to the furnace side of the assembly table, the load to be redistributed is returned to the assembly table by means of "C" hooks. The drag beam is then reversed and used to push the blooms one at a time on the runout table. From the runout table the blooms are reassembled on the remaining bed as desired.

CAPACITY OF THE LOADING FACILITIES

As shown in Table II, a comparison was made of the bloom rolling time and the estimated furnace loading time for typical bloom sections and lengths. This comparison shows that loading by the proposed facilities is an average of two to three times faster than necessary to keep up with the production of blooms, which varies from 69 to 104 tons per hour. The loading of the furnace car within the estimated two hour limit necessary to prevent the temperature of the coldest bloom from falling below 600 F is therefore governed by the mill rolling rate. Since 69 tons per hour is the minimum rolling rate, and the rated furnace capacity is 100 tons, one hour and 27 minutes is required to roll a capacity furnace load. As many as 138.5 tons of 5½ × 5½ in. blooms 16 ft-0 in. long may be charged into the furnace at one time. At a rolling rate of 73 tons per hour for this size, one hour and 54 minutes would lapse during the rolling of this super-capacity furnace load.

REQUIRED SIZE OF THE CAR BOTTOM FURNACES

While the furnace length is based upon the length of the longest bloom to be processed, a trial and error furnace loading study was made to determine the furnace width and height. Table III shows the furnace loading capacity for a full load of each of various typical sizes and lengths of blooms. The overall dimensions of a maximum load are 6 ft-0 in. wide, 7 ft-2 in. high and 32 ft-0 in. long. Later development of the bloom handling method and the design of the spacer units made necessary the specifications of the car bottom furnaces to accommodate a car 9 ft-6 in. wide, 35 ft-0 in. long and a full load 8 ft-0 in. above the top of the car floor.

A tabulation of sizes and lengths producing sub-capacity loads was prepared but not included in this paper. Since blooms ranging from 5 ft-0 in. to 16 ft-0 in. long comprise 90 per cent of all the controlled cooled product, lengths which cannot be loaded efficiently falling in this length group are a matter of more concern than those which fall in the 17 ft-0 in. to 32 ft-0 in. length group. It should be remembered that these

TABLE II

COMPARISON OF ROLLING TIME TO LOADING TIME FOR TYPICAL BLOOM SECTIONS AND LENGTHS

Bloom section, in.	Bloom length, ft-in.	Minimum rolling time per car layer, minutes	Minimum loading time per car layer, minutes	Ratio of rolling time to loading time
5 x 5	10-0	13.32	5.95	2.24
5 x 5	5-0	13.32	5.23	2.55
5½ x 5½	21-0	10.70	4.12	2.60
5½ x 5½	16-0	16.20	5.23	3.10
5½ x 5½	12-0	12.24	5.23	2.34
5½ x 5½	10-0	15.60	5.95	2.62
6 x 6	20-0	9.6	4.12	2.33
6 x 6	10-0	14.40	5.95	2.42
6 x 6	6-0	14.25	5.23	2.72
7 x 7	14-0	13.04	5.23	2.49
7 x 7	12-0	12.60	5.23	2.41
7 x 7	10-0	14.04	5.95	2.36
7½ x 7½	15-0	13.84	5.23	2.65
7½ x 7½	10-0	14.88	5.95	2.51
8 x 8	11-0	11.84	5.23	2.27
8 x 8	7-0	14.08	5.23	2.70
9 x 9	12-0	12.28	5.23	2.35
9 x 9	10-0	15.30	5.95	2.57
9⅞ x 9⅞	21-0	12.00	4.12	2.92
10 x 9½	10-0	17.40	5.95	2.92
10 x 11½	15-8	14.40	5.23	2.75
10 x 11½	12-0	10.92	5.23	2.08

TABLE III

FURNACE LOADING CAPACITY

FOR TYPICAL BLOOM SECTIONS AND LENGTHS

MAXIMUM LOAD DIMENSION 6 FT-0 IN. WIDE X 7 FT-2 IN. HIGH X 32 FT-0 IN. LONG

Bloom section, in.	Bloom length, ft-in.	Blooms per pack	Packs per layer	Blooms per layer	Layers per car	Blooms per car	Weight per bloom	Load per car
5 x 5	10-0	6	6	36	7	252	850	213,000
5 x 5	5-0	18	4	72	7	504	425	216,000
5½ x 5½	21-0	6	2	12	7	84	2160	181,000*
5½ x 5½	16-0	6	4	24	7	168	1650	277,000
5½ x 5½	12-0	6	4	24	7	168	1240	208,000
5½ x 5½	10-0	6	6	36	7	252	1030	260,000
6 x 6	20-0	5	2	10	6	60	2440	146,000*
6 x 6	10-0	5	6	30	6	180	1220	220,000
6 x 6	6-0	5	10	50	6	300	734	220,000
7 x 7	14-0	4-5	4	18	6	108	2330	252,000
7 x 7	12-0	4-5	4	18	6	108	2000	216,000
7 x 7	10-0	4-5	6	27	6	162	1670	271,000
7½ x 7½	15-0	4	4	16	6	96	2670	256,000
7½ x 7½	10-0	4	6	24	6	144	1910	277,000
8 x 8	11-0	4	4	16	5	80	2400	192,000*
8 x 8	7-0	4	8	32	5	160	1520	243,000
9 x 9	12-0	3-4	4	14	5	70	3300	231,000
9 x 9	10-0	3-4	6	21	5	105	2750	289,000
9⅞ x 9⅞	21-0	3	2	6	5	30	6950	209,000
10 x 9½	10-0	3	6	18	5	90	3240	292,000
10 x 11½	15-8	2-3	4	10	5	50	6200	310,000
10 x 11½	12-0	2-3	4	10	5	50	4720	236,000

* Under required 200,000-lb capacity as a result of excessive voids in load.

loading efficiencies are based upon loads consisting of one specific size and length only. Ordinarily, the sizes should vary enough to assure a load of 100 tons or better. The lengths which do not permit capacity loading must be scheduled for a time that two furnaces are available for use.

Table III, showing furnace loading capacity for various bloom sections, may be used as a guide to efficiently schedule controlled cooled blooms for rolling. It is seen that the furnace capacity may be increased as much as 50 per cent for the largest blooms.

Based upon 100-ton furnace loads, grades of steel such as SAE 4140, SAE 4150 and SAE 52100 may be controlled cooled by the facilities described above at a rate of 400 tons every 24 hours while grades such as SAE 3312 and SAE 4340 may be controlled cooled at a rate of 400 tons every 36 hours.

The postulated arrangement of the mill and conditioning buildings as shown in Figure 1 is particularly well adapted to the controlled cooling plan in that the blooms may be delivered directly into the steel conditioning building which is the next processing station. Although desirable and recommended for new construction, the latter arrangement is not essential. Benefits of the basic plan may be gained by adapting the equipment to existing mill facility layouts.

DISCUSSION

PRESENTED BY

P. E. HAGLUND, Superintendent, Raw Materials and Semi-finished, Ford Motor Co., Dearborn, Mich.

P. E. Haglund: Flakes in steel is a subject that has been thrashed around for the last thirty years. At the beginning of World War I this subject was not too well understood. We were making a lot of alloy steels at the time, that is, chrome, nickel, molybdenum and chrome-nickel silicon steels, and were getting into plenty of trouble.

I happened to be making die steels on an electric furnace. Very often the die block was forged directly from the ingot, laid down on the floor to cool, and when the flakes did occur on the sections tested, I was called on the carpet and told in no uncertain terms how bad I was at making steel. The worst part of it was, I had to remelt those heats. They were given right back to me again

Some time later the blacksmith shop started to cool the blocks more slowly and then there were better results

It might be well at this time to mention a few of the reasons for the flaking. The early investigators blamed it on rapid cooling through the lowered critical ranges of alloy steel altogether. To overcome this trouble, they started to bury the steel in ashes or sand. Later on they discontinued that theory nearly altogether, and did not blame it on the volume-change, while going through the critical range, but blamed it on inclusions, segregation dendritic pattern, and hydrogen. Hydrogen is probably the most substantial cause — that is, steel made with a minimum of hydrogen has very little objectionable flakes, and steel in which hydrogen is injected, flakes readily, so probably the principal reason, or the main contributing cause of flaking or ruptures in the steel, is hydrogen.

Electric Equipment for

HIGH SPEED 2-STAND TEMPER PASS MILLS

. . . . temper mill power requirements is a subject that still requires much additional fundamental test data, if the best motor selections are to be made . . . .

By R. E. MARRS
Steel Mill Division
General Electric Co.
Schenectady, N. Y.

▲ THE second cold rolling operation of steel after an annealing process is usually referred to as skin pass or temper rolling. This rolling operation develops a grain structure, surface hardness and a certain degree of ductility that is most desirable in the final processing of steel into finished products.

Because of the ever increasing demands on rolling mills for more of this high quality steel at lower production costs, it is becoming more and more necessary to do this temper rolling in coil form at increasingly higher speeds. The annealed steel is soft and usually rather loosely coiled. It must therefore (particularly in the lighter gages) be handled carefully throughout the rolling operation to prevent distortion or other damage.

The actual reduction made in thickness during this rolling operation depends on the degree of hardness or ductility desired. The elongation usually does not exceed 4 or 5 per cent. The tension in the strip over the section being rolled should be above the elastic limit but below the ultimate strength of the material.

When this total tension exceeds that which can be obtained satisfactorily from a loosely wound coil on the entry side of the mill or even more than that desirable for winding reel tension on the delivery side of the mill, the use of auxiliary tension rolls is advantageous. These are located on either or both the entry and delivery sides of the mill. For the lighter tinplate gages there seems to be an even greater need for control of strip tension between two stands which are actually making some reduction or elongation of the metal. The need for a quality product rolled in this manner has resulted in the development of the two-stand temper pass mill. This type of mill holds an extremely important place in cold rolling mill operations.

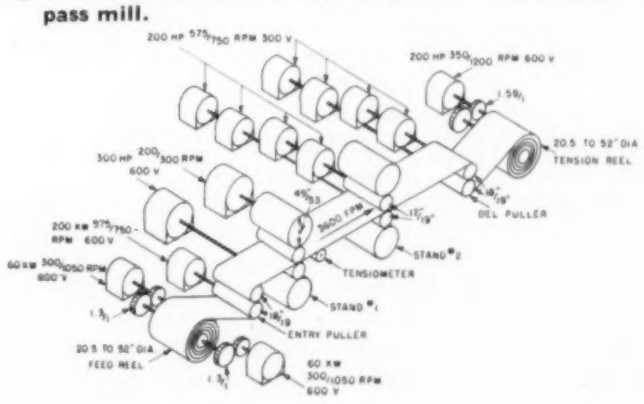
There are a number of such 2-stand mills in service today for temper rolling steel in coil form. There are some in the process of manufacture that will provide operating speeds as high as 5000 fpm. Very little information is available on the power requirements of the individual drives and there probably is no other type of mill that invites such a wide variety of opinion on the actual machine ratings. This paper describes the electric equipment which seems appropriate for a typical 2-stand mill operating at a maximum speed of 3600 fpm.

MECHANICAL ARRANGEMENT

Figure 1 shows the mechanical arrangement of the mill. The essential roll diameters and coil diameters are given as these are necessary for the selection of motor speed ranges. It will be noted that in this arrangement the material passes from left to right and that the driving motors of stand 1 are connected directly to the back-up rolls, whereas on stand 2 the driving motors are directly coupled to the work rolls. No pinion stands are necessary. Therefore the possibility of strip marking from gear tooth chatter or rolls of unequal diameter is eliminated.

Coupling directly to the back-up rolls has one distinct advantage in that it is not necessary to disconnect the driving spindles when changing work rolls. Also the greater spacing between the back-up roll centers gives the motor designer more space between machine arm-

Figure 1 — Mechanical arrangement for 2-stand temper pass mill.


200 HP 575/750 RPM 300 V
200 HP 350/1200 RPM 600 V
20.5 TO 52" DIA TENSION REEL
300 HP 200/300 RPM 600 V
DEL PULLER
200 KW 575/750 RPM 600 V
STAND #2
TENSIOMETER
STAND #1
ENTRY PULLER
20.5 TO 52" DIA FEED REEL
60 KW 300/1050 RPM 600 V

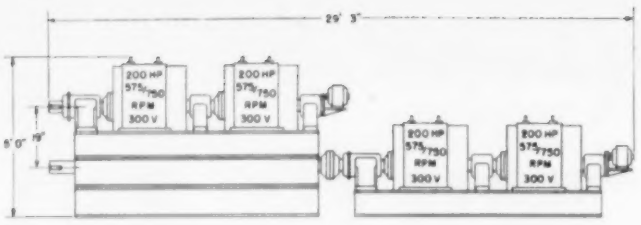


Figure 2 — A 4-motor twin drive unit was used to drive stand No. 2.

atures. This is particularly useful in the larger motor ratings.

On stand 2 the amount of power transmitted through the work rolls for the rolling and strip tension loads is relatively greater than that on stand 1 and, to avoid the possibility of roll slippage or chatter, the driving motors are coupled to the work rolls. The motors for stand 2 must therefore have small diameters, and, in this particular case, required two motors coupled in tandem for each roll. An outline arrangement of these motors is shown in Figure 2. It will be noted that the shaft extensions are on centerlines 19 in. apart. There is one bearing on the lower motor jackshaft which is not visible in the outline. These small diameter motors are particularly advantageous where very rapid rates of acceleration and deceleration necessitate a low inertia drive.

The shaft diameters for motors of such design are governed by the crosssectional area to resist deflection at high speed. This results in a shaft diameter much larger than required for transmission of the maximum torque developed in them. The possibility of breaking a motor shaft or even a spindle of the size mill builders usually furnish with their equipment is therefore very remote. It should be noted, however, that if the shaft or roll neck did break, the fracture could occur at such an angle as to develop enormous thrust forces on the motor armatures. The motors are provided with bearings suitable for all thrust developed under normal operating conditions, but it is not practical to build thrust bearings in either such motors or pinion stands to resist the forces which could possibly develop by very acute angle breaks in the rotating members. Furthermore, it is equally important to take note of the thrust forces which may result in careless changing of rolls. If a heavy ram is used to drive a new roll in position when it is not properly alined with its spindle coupling, sufficient thrust may develop to damage shafts, bearings or even foundation bolts and keyways. This possibility is present with either pinion stands or direct coupled drives, and it is not practical to build them to withstand such abuse.

POWER REQUIREMENTS

The power requirements for temper rolling for a given reduction or elongation are generally conceded to be somewhat above those requirements for other cold rolling mills. Yet there is a great difference of opinion among mill operators and equipment builders today regarding the actual machine ratings of the individual drives. For example, the horsepower ratings recently proposed for the delivery puller drive on a certain new mill varied by more than 4 to 1. In general, there seems to be a tendency to put duplicate machines on stand 2 and the delivery puller. Similarly stand 1 motor rating is frequently specified to have a horsepower rating equal to or slightly less than stand 2, and it is not always specified whether or not this rating is selected on the basis of rolling load or operating as a drag unit, adding to the back tension on stand 2.

If there is a limit to the strip tension which it is desirable to hold at the reels, then there is also a limit to that tension which can be obtained by a single puller drive. With the usual arrangement of steel puller rolls, one above the other, the tension developed by them cannot be more than approximately three times the reel tension without the danger of strip slippage over the rolls. This can be proved by a formula which defines the maximum tension ratio as being equal to 2.73 raised to the power of 6.28 F where F is the coefficient of friction and assumed to be not over 0.18. This formula is derived from the wire rope power transmission formula given in Marks Handbook.

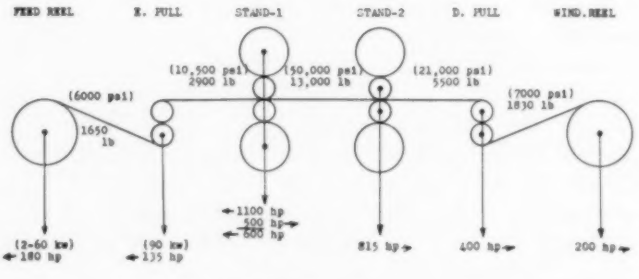
If, for example, referring to Figure 3, a 30-in. wide strip, 0.0088 in. thick is assumed and it is specified that the winding reel tension shall not exceed 7000 psi (or 1830 lb total) at 3600 fpm, then the reel motor load is approximately 200 hp. The delivery tension rolls cannot then exert more than 21,000 psi, 5500 lb total against stand 2. The puller motor need not therefore be greater than 400 hp to increase strip tension from 1830 lb to 5500 lb at 3600 fpm.

Now, if 13,000 lb tension (approximately 50,000 psi) between stands 1 and 2 is desired, then there must be approximately 815 hp available on stand 2 just to maintain the difference in strip tension at that point.

Similarly, if the unwinding reel tension is specified to be 1650 lb (approximately 6000 psi) available from two 60-kw drag generator units, then the entry puller tension against stand 1 cannot be over approximately 1.76 times 1650 or 2900 lb to avoid slippage on the one puller roll. This can be proved by the formula defining maximum tension ratio for one-half wrap on a single roll drive as 2.73 raised to the power of 3.14 F, where F is again 0.18. This difference of 1250 lb between these values at 3600 fpm is equivalent to 135 hp or a drag unit output rating of 90 kw.

Referring back to stand 1, the difference between front tension of 13,000 lb and back tension of 2900 lb or 10,100 lb at approximately 3600 fpm is equivalent to 1100 hp. However, this value will be reduced by the amount of work performed on the strip. It might be

Figure 3 — Sketch gives an approximate distribution of power when rolling 0.0088 in. x 30 in. strip at 3600 fpm with 2.4 per cent elongation.



hastily concluded that if all the work were done on the strip at stand 1, and it amounted to approximately 500 hp, that a total rating of (1100–500) or 600 hp would be satisfactory for stand 1.

Data taken on this particular 2-stand mill indicate that 2.25 hp-hr per ton for each one per cent elongation are required. It would be most desirable to have more operating data on other mills to confirm this figure. However, this particular mill, running at 3600 fpm and delivering 92 tons per hour with a rolling load of 500 hp on stand 1, under the above conditions would result in an elongation of 2.4 per cent.

These values represent assumed conditions of operation, but they are reasonably well substantiated by tests made at the time the mill was placed in service. At the present time, however, the rolling practice has been changed and the entry puller is not being used. For a given elongation, this results in stand 1 having to make up for the loss in the tension previously supplied by the entry puller.

For greater elongations in the order of 4.1 per cent under approximately these same tension conditions, the drag load of stand 1 is reduced. For example, with the entry puller disconnected, the actual drag load developed by stand 1 is approximately 350 hp. The total net rolling load for this condition has been found to be approximately 850 hp.

ACCELERATION AND DECELERATION TORQUE REQUIREMENTS

The above analysis has been made only on the basis of the continuous rolling and tension loads required. It is also important that the motors be suitable for the acceleration and deceleration rates required. Usually it is not necessary to accelerate or decelerate this type of mill, operating at maximum speed, in less than twenty seconds.

Table I shows the actual inertia of the various motors and their connected loads all referred to the motor shafts. In addition the tabulation shows the actual torque required to accelerate each drive in twenty seconds, the motor full load torque rating, and the per cent of full load motor torque rating to accelerate each drive. It will be noted that with full rated load on each drive, the torque requirements are well within the permissible total of 200 per cent momentary rating on such mill type motors.

If it should be desired to gradually increase the accelerating rate of the mill, the winding reel motors would be the first to reach their permissible overload ratings.

Similarly, an increase in decelerating rates will first involve the permissible overload ratings of stand 1, then the unwinding reel. This is true because both drives as described are operating as drag units, and their output must be increased during the decelerating period.

As the accelerating and decelerating rates of the mill are increased, it becomes more and more important to adjust the accelerating torque of each motor in proportion to its connected inertia by proper forcing methods.

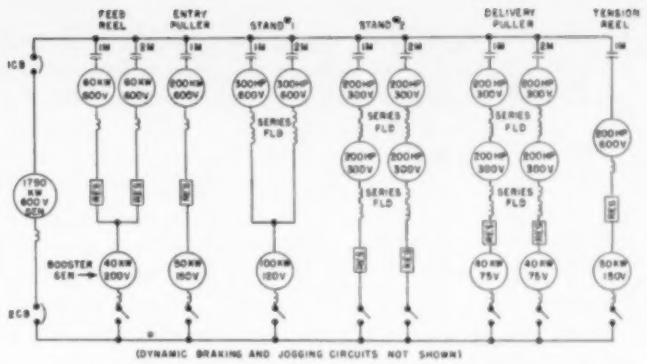


Figure 4 — The armature circuit arrangement is given in this diagram.

ARMATURE CIRCUITS

Referring to Figure 4, showing the main armature electrical circuits, each of the drive ratings just discussed with the exception of the pullers, will be recognized again. It has been found that only about one-half power, originally intended for experimental purposes on the pullers can be utilized. The one half of the delivery puller unit which is not used is an electrical and mechanical duplicate of the units on stand 2. Therefore the unit not used has been removed from service and serves as a spare motor for both stand 2 and the remaining puller unit.

It will be noted that all motors are supplied by one common generator. It appears that the maximum continuous load which could be imposed on the generator would occur when stand 2, the delivery puller and winding reel, are fully loaded and there is practically no return of power by pump-back from stand 1, the entry puller, or the unwinding reel. Based on this

TABLE I

INERTIA AND TORQUE VALUES FOR EACH DRIVE

	Feed reel		Entry puller	Stand No. 1	Stand No. 2	Delivery puller	Winding reel	
	Empty	Full					Empty	Full
Motor Wk^2, lb-ft^2	542	542	520	8,000	1,280	1280	880	880
Mill Wk^2, lb-ft^2	1590	39,700	3098	167,232	22,060	3451	1750	28,400
Total Wk^2, lb-ft^2	2132	40,242	3618	175,232	23,340	4731	2630	29,280
Motor torque	800	2,800	1695	10,500	5,600	5600	875	3,000
Torque to accelerate in 20 sec	364	1,960	440	8,530	2,840	776	449	1,660
Per cent motor torque to accelerate in 20 sec	45.5	70.0	26	81.2	50.7	13.9	51.3	55.7

assumption, a 1250-kw generator would have been satisfactory. However, to be certain of ample power for experimental rolling it was decided to use a 1750-kw, 600-v generating unit.

Stand 2 being the pivot unit, its preselected speed will determine the strip speed. All other drives have IR drop boosters to compensate for line resistance. In addition, these boosters provide means of compensating for roll diameter variation, and strip elongation. They also serve as a means of regulating "stalled" tension, and means for adjusting line voltage proportional to speed changes effected by motor field adjustment of stands 1 and 2. The voltage rating of the boosters are therefore determined by these requirements.

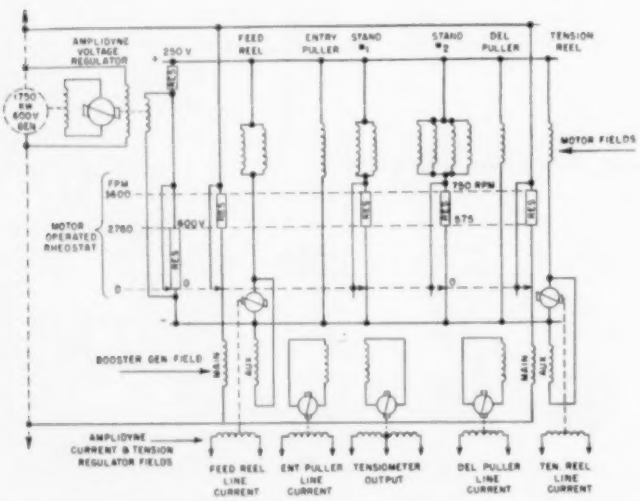
EXCITATION AND REGULATOR CIRCUITS

Figure 5 shows a typical arrangement of machine excitation and regulator circuits. The main generator voltage is adjusted by means of a motor operated rheostat through a rotating regulator regulating unit. It is extremely important to have this voltage held constant, particularly at the threading or jogging voltage levels. A change in load on any drive does not then affect the line voltage or operating speed of the other drives.

The motor operated rheostat functions first to raise the generator voltage to obtain operating speed of 2760 fpm, then to weaken 1 and 2 stand motor fields for maximum operating speed of 3600 fpm.

When the mill speed is increased by motor field adjustment on stand 1 and 2, the armature voltage of both unwinding and winding reels is increased proportionately. This is done to maintain constant strip tension and is accomplished through another dial on the main motor operated rheostat in series with the line booster shunt fields. These shunt fields are excited from the main generator armature voltage in a direction to give the booster a voltage which opposes the main generator voltage. Therefore, when the rheostat dial resistance is inserted, the reel motor armature voltage increases to 600 volts.

Figure 5 — Machine field excitation system.



Excitation of the reel motor fields is varied by means of a rotating line current regulator. This regulator functions to hold constant current. It also varies the motor armature voltage a small amount through an auxiliary field on the line booster. This auxiliary field serves a dual purpose in providing a means of holding stalled tension and assists in forcing action on acceleration and deceleration of the drives.

The puller drive motor fields are connected across a constant voltage. The line booster in the armature circuits of these drives is excited by another line current regulator. These regulators holding constant line current and essentially constant tension need only to adjust the line voltage applied to the motors in proportion to the mill speed when operating above base speed of stand 2.

The booster voltage in stand 1 armature circuit is controlled by the output of a tensiometer. The strip under tension presses against the tensiometer roll and movement of the tensiometer roll in turn adjusts the line booster voltage to obtain speed of stand 1 required for the pre-selected value of strip tension.

It will be noted that all drives are under the influence of one or more rotating regulators at all times functioning either on voltage, current or actual strip tension.

TWIN DRIVE MOTOR LOAD BALANCE

It has been found that the inherent resistance of the twin drive units, plus a slight amount of series resistance is sufficient to assure a reasonable load balance between the motor armatures. There appears to be no necessity for cross connected series fields, nor load balance regulators unless the speed range, provided by motor field adjustment, is greater than that specified for this particular mill. In fact, one temper mill twin drive unit in the process of manufacture is being designed so that the mill operators may, if they desire, couple both motors in tandem to transmit all the power for one stand through one spindle.

OPERATOR'S REMOTE CONTROL EQUIPMENT

Figure 6 is a photograph of the mill from the operator's viewpoint. A full complement of control devices and indicating instruments are provided at the mill stands. These are arranged in several cabinets for the operator's convenience. They include means of jogging each drive independently or in tandem, adjustment of threading speed, preselection of running speed and strip tension for each drive. Normal stopping of the mill is accomplished by rapidly increasing motor field excitation and lowering the generator voltage for regenerative braking. Emergency stopping by independent dynamic braking of each drive may be used if desired.

CONCLUSION

In this brief description of the electric equipment for a typical, high-speed, 2-stand temper mill several references have been made to the difference of opinion regarding operating requirements. When this difference

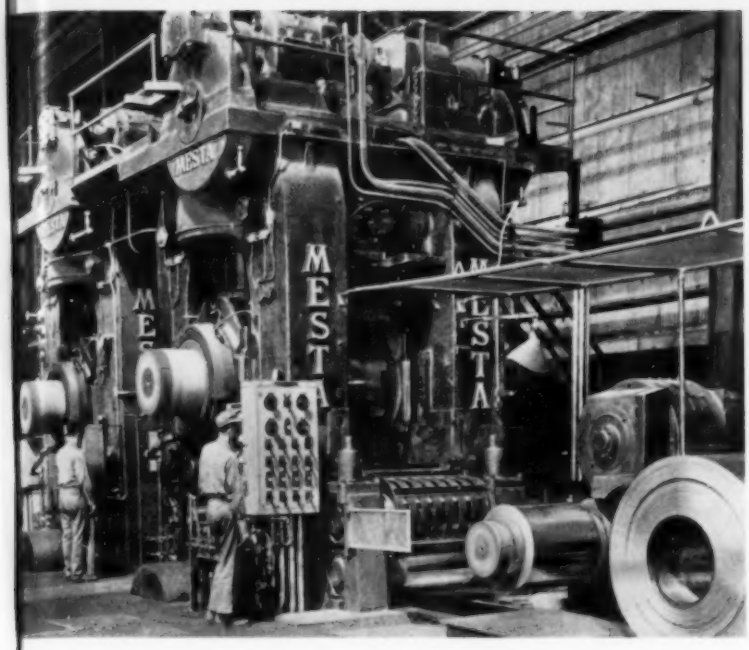


Figure 6 — The maximum speed of this 2-stand temper pass mill is 3600 fpm.

exists it is most difficult to select machine ratings that will be satisfactory to both mill operators and equipment builders. It is hoped that this paper will help unify these conflicting opinions.

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DISCUSSION

PRESENTED BY

R. H. WRIGHT, Steel Mill Engineer, Metal Working Section, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

FRED O. SCHNURE, Electrical Superintendent, Bethlehem Steel Co., Sparrows Point, Md.

F. P. DAHLSTROM, Rolling Mill Consultant, New Haven, Conn.

R. E. MARRS, Steel Mill Division, General Electric Co., Schenectady, N. Y.

R. H. Wright: One of the striking features of present day temper pass mills is that there seems to be little or no standardization of design. As Mr. Marrs has stated, the electrical manufacturers are sometimes a bit embarrassed by the variety of the motor lists which are submitted on the same job. The variations are perhaps not quite as great for two-stand mills as for single stand mills. It is not unusual for the motor lists which are submitted on the same project to differ as much as two to one on the horsepower requirements of some of the drives.

The question quite naturally arises as to whether all the proposed mill designs would be equally satisfactory. The amount of work to be done at a given point in either type of mill definitely fixes the horsepower which should be applied at that point. So if the user has given all the mill builders the same idea as to the overall performance requirements, there should not be much difference in the motor lists.

The higher temper mill speeds which are now coming into use will no doubt persist. For higher speeds it is more essential to have an accurate determination of motor capacities. The ultimate user will find it profitable to make a careful analysis of his requirements in the early stages of every temper mill project.

Fred O. Schnure: Mr. Marrs mentioned that the bearings on the drives were not built with sufficient capacity to take care of any extraordinary mill thrust, and that is true. It would be very difficult to build in motors of such small size enough thrust capacity to withstand any values of thrust that might be transmitted from the mill.

So this mill was laid out without thrust bearings, and at the start we experienced, on one of the drives, quite a bit of trouble. We made up a stand consisting of an old pinion stand without the pinions, arranged to take care of the thrust. By the time this was ready to be installed, it was discovered that the spindle carriers were a little out of line, and the trouble experienced was due to shock caused by bumping the rolls into position against this mis-alinement.

This shock had been transmitted to the motor bearings so we had to burn a little off the spindle carriers. No more trouble was experienced and it was not necessary to install the thrust bearings. The mill itself, from an electrical standpoint, has operated very satisfactorily.

F. P. Dahlstrom: I have spent the last few years working on cold reduction and temper mill problems. The basis on which many present mills are designed and operated can give erratic readings.

Mr. Wright and I have had some discussions on the power division between upper and lower rolls in cold reduction mills, and I then computed that the friction of the pass must be about 0.03, since the mill rolls are running on a fluid film. This is the opposite condition to the temper mill, because there the condition of friction is at the other extreme.

Until a complete analysis is made of what is going on in the pass of a temper mill, there will be marked differences of opinion on the design and operation of the mill. In addition, the full possibilities of the mill cannot be realized until we have a more complete fundamental understanding.

Referring to your statement that power on stand 2 is greater than stand 1, from Figure 3, the load on stand 2 is 7500 lb, and that on stand 1 is a negative 10,100 lb. Does this mean that the figures on the sketch are in error?

R. E. Marrs: Mr. Dahlstrom is correct in that the total power involved or work done on the strip is greater at stand 1 than at stand 2. However, the actual amount of this total power transmitted through the work rolls and motor shafts is greater on stand 2.

ELECTRIC ARC FURNACE STEEL QUALITY

. . . . the production of steel in the electric arc furnace has been accelerated greatly because of the demands resulting from two world wars . . . .

By ROBERT SERGESON
Chief Metallurgical Engineer
Rotary Electric Steel Co.
Detroit, Mich.

▲ BEFORE the introduction of the electric arc furnace, quality steels, such as tool steels and watch spring steels, were melted by the crucible process.

In 1904 the first electric arc furnace in the United States was installed in the Halcomb Steel Co., Syracuse, N. Y. It was a three-ton, single phase furnace.

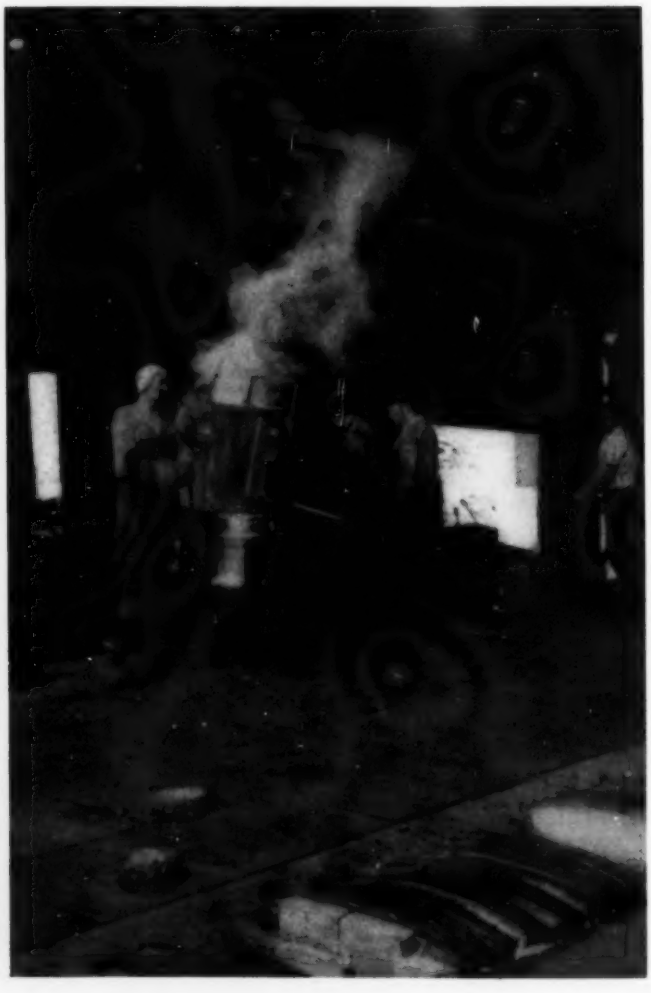
World War I gave marked impetus to the electric arc furnace and World War II's effect was greater. The following Table I lists the growth of electric furnace steel production.

The electric arc furnaces in the steel industry are divided into acid and basic types. Acid, as the name implies, has an acid lining of silica brick and a sand bottom. Except for carbon and alloy, the chemistry is the same as the charge. The process is applied to the making of steel castings.

The basic furnace has a bottom of dolomite or magnesite. Slags are added to remove the sulphur and phosphorus. The phosphorus is removed by a basic oxidizing slag of lime and iron oxide, which also removes most of the silicon and manganese before attacking the phosphorus to form calcium phosphate ($Ca_3\ P_2\ O_8$). Sulphur is principally removed by a second slag low in

Figure 1 — Before the advent of the electric furnace, most quality steels were made by the crucible method. The photograph shows the workmen pulling a 1000-lb pot from a crucible furnace.

Figure 2 — The operator is shown pouring a crucible steel ingot.



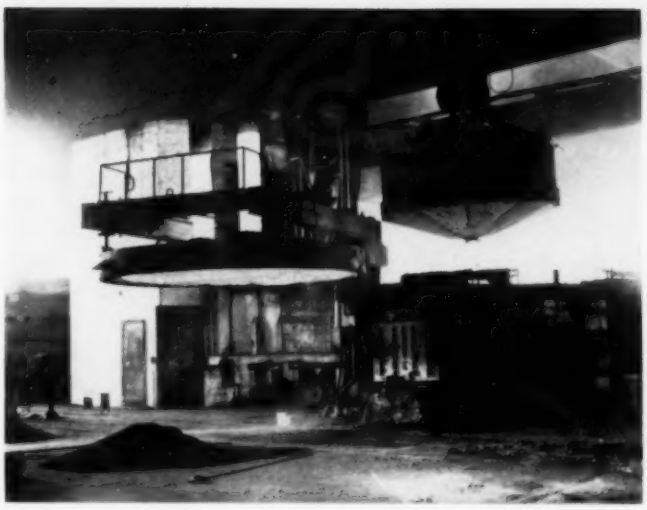


Figure 3 — Top charging is an efficient method of charging the electric furnace. The scrap is shown in the round charging box hanging from the crane.

Figure 4 — The charging box is shown open after charge has been dropped into 60-ton electric furnace.

iron oxide and strongly reducing. In this slag, lime and carbon combine to form calcium carbide, which reacts with sulphur to form calcium sulphide. While phosphorus is desirable from a corrosion and a machining standpoint, it is undesirable for highly stressed parts as it embrittles the steel. Sulphur is very desirable for free machining steels, and in relatively small amounts for certain moderately stressed machinery parts (0.04 to 0.06 — e.g. 8641). However for highly stressed parts as in aircraft and bearing steels, it must be kept low (0.025 or under).

TABLE I

Year	Annual capacity, tons
1913	30,000
1918	510,000
1927	Up to this time largest furnace was 25 tons except Timken 85-ton furnace
1938	1,029,000
1943	4,629,000
1948	5,329,000

TABLE II

Furnace capacity	Shell diam	Transformer	Electrode
6	11 ft	2,700 kva	12 in. graphite
15	13 ft-6 in.	4,500 kva	14 in. graphite
35	16 ft-6 in.	10,000 kva	18 in. graphite
50	18 ft	15,000 kva	20 in. graphite
60	19 ft	15,000 kva	20 in. graphite
70	20 ft	16,000 kva	20 in. graphite

TABLE III

Group	Types of steel
1	Rimming, semi-killed and aluminum killed low carbon steels
2	Resulphurized steels
3	Commercial forging steels
4	Cold drawn and coil spring
5	Cold heading and ring gear
6	Aircraft and oil hardening bearing steels
7	Special steels — stainless, high speed, die steels, etc.

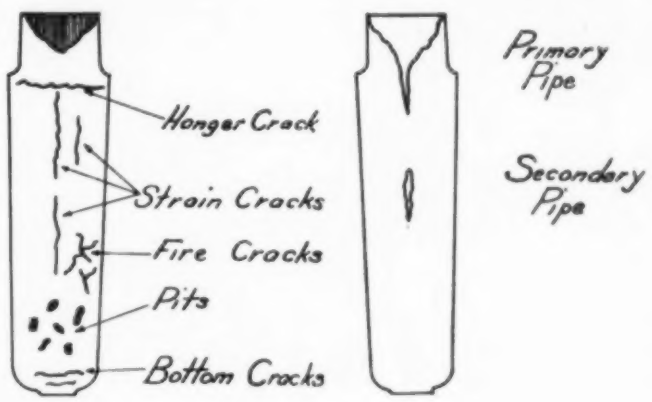
SIZE OF ELECTRIC ARC FURNACES AND EQUIPMENT

As mentioned in Table I, up to 1927, the largest furnace capacity was twenty-five tons (i.e. with the exception of the 85-ton, six electrode Timken furnace). Since 1927, furnace capacity has been materially increased. Table II summarizes the relationship of furnace capacity, shell diameter, transformer capacity, and electrode size.

ELECTRIC ARC FURNACE QUALITY STEELS

The electric arc furnace is well adapted to produce a wide variety of quality steels. It must be recognized that the qualifying word "quality" has a different meaning and calls for different requirements for various types of steel. For example, a high quality free machining steel would be judged by different tests than a bearing steel. The quality requirements depend upon the users' processing, fabrication and the end use. Table III lists a grouping of various types of steel.

Figure 5 — Sketch shows typical defects in hot top ingot.



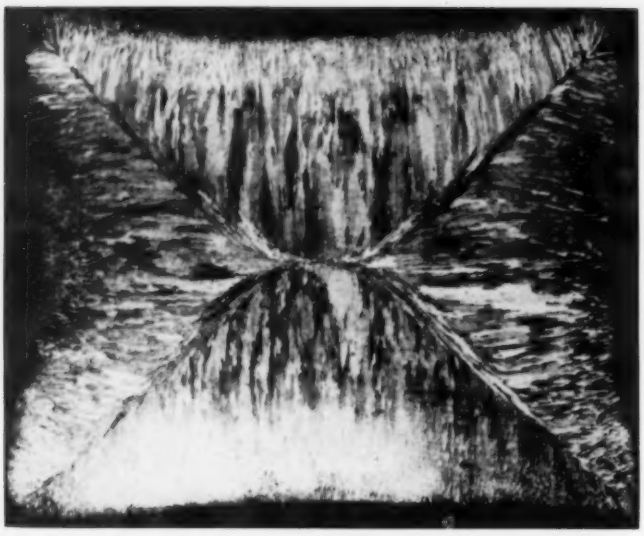


Figure 6 — This cross section of a 17 x 20-in. ingot of 18 per cent chrome, 8 per cent nickel, low carbon stainless steel shows dendritic structure.

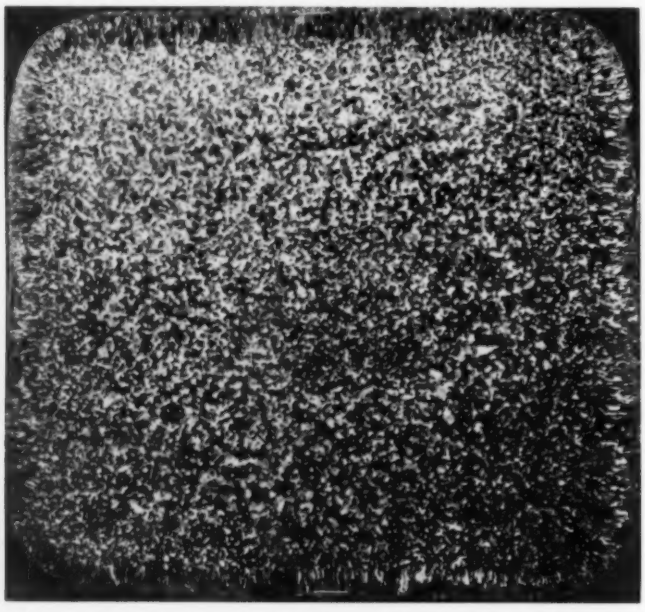
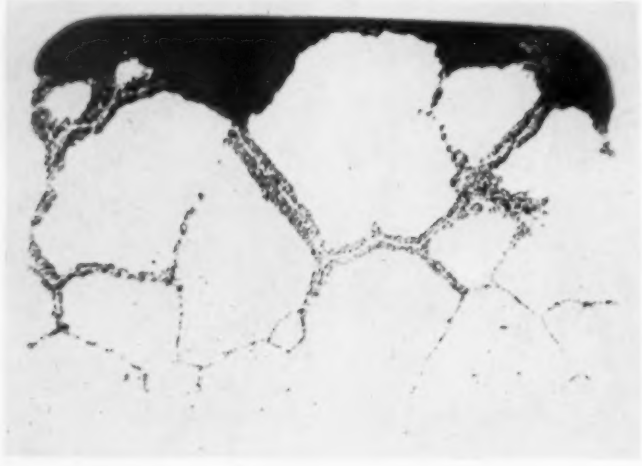


Figure 7 — The use of nitrogen has helped to maintain a relatively fine grain in this 28 per cent chrome high nitrogen stainless steel which was poured in a 10-in. ingot.

Figure 8 — If the temperature of the heating furnace is too high, oxides will penetrate on the grain boundaries.



Each group requires certain changes in melting and processing procedures.

Group 1 — The rimming, semi-killed and aluminum-killed low carbon steels of this group are generally made in the basic open hearth furnace but in the past several years have been successfully made in the electric arc furnace. They are made with single slag practice and finish with relatively high FeO (15/30). The tapping and pouring of these steels are very important factors in regard to quality.

Group 2 — Resulphurized steels have been made in the electric arc furnace for many years. They are also made with the single slag process and relatively high FeO. A uniform distribution of sulphur is important.

Groups 3 *and* 4 — These groups may be made with the single slag process. Their chief requirement is good surface with normal soundness and cleanliness. Group 4, the cold drawn and coil spring types, require closer control in operations subsequent to melting.

Group 5 — This group is generally made by the double slag process. Both surface and cleanliness are the chief requirements. Cold heading stock must have non-metallic inclusions in such form as not to cause ruptures in cold upsetting. In the ring gear type, the inclusions must be of such a nature to permit long tool life in machining.

Group 6 — Aircraft and oil hardening bearing steels. This group requires the utmost in melting to meet rigid specifications and requirements for surface, internal cleanliness, close hardenability limits, etc. The double slag melting process finishing with low FeO (0.5) is usually employed for this group.

Group 7 — Special steels — stainless, high speed, die steels, etc. Each of this group requires special melting and processing.

FACTORS INFLUENCING QUALITY

1. *Raw materials* — Scrap is the chief raw material of the electric arc furnace. It is essential that it be relatively clean and free of excessive tramp elements such as tin, zinc, lead and copper. Excessive amounts of these tramp elements make the metal hot short. It is important that scrap be properly prepared for efficient charging.

Limestone, lime, sand and spar fluxes must be dry. If they carry moisture they will introduce hydrogen gas into the melt which is difficult to remove, and if sufficient is present it will cause ingots to back up and "bleed."

2. *Melting* — In general, fast melting is an important factor for success in making electric furnace steel. The less time that is required in melting, the less oxide will be found during this operation. The importance of this cannot be over estimated. It is practically the only opportunity for "making time" without affecting the quality of the final product.

3. *Molds and pouring* — The mold size and shape is determined by the end product. The molds must be at proper temperature and have a suitable mold wash if best ingot surface is to be obtained. The mold size and ladle size determine the nozzle size for pouring, although this is modified somewhat by the type of steel being poured; e.g., nitralloy 135 steel requires a larger

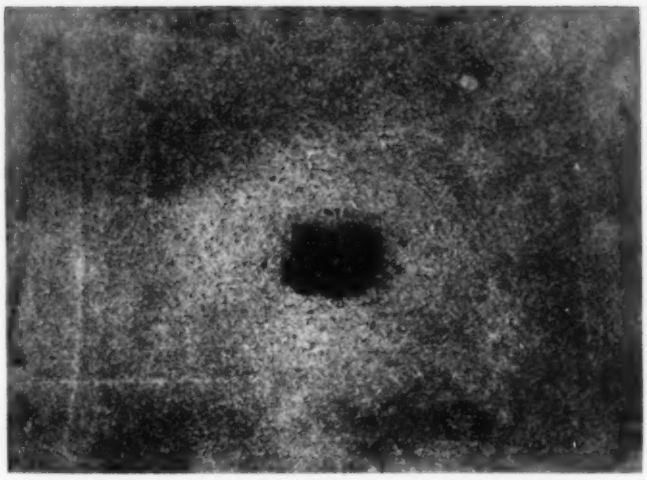


Figure 9 — Because of insufficient croppage, carbon segregation can be seen in the center of the billet.

nozzle than SAE 4140 due to the nitralloy 135 being more sluggish.

4. *Ingots* — The time in molds and time before charging into soaking pits (track time) has a marked influence upon the surface conditions of the ingot. Proper heating cycles for each grade of steel must be set up to insure not only good surface but sound internal conditions.

5. *Rolling* — Proper initial and subsequent drafts must be used and in many cases "hot scarfing" applied at a given reduction to produce a satisfactory bloom, billet or slab. The method of cooling these products after rolling to preserve internal soundness depends upon the grade of steel involved. Most alloy steels should be slow cooled (especially in billet sizes), after rolling. Covered pits or ashes are the usual mediums for cooling.

TESTS FOR DETERMINING QUALITY

The following metallurgical tests are generally applied for appraising the quality of a steel.

1. *Etch test* — This test is the most common. Cross sections of billets or bars are etched in hot acid (hydrochloric acid and water 1 to 1) to bring out any surface or internal defects in the steel. Stepdown tests are also etched to locate the number and length of large inclusions.

2. *Non-metallic* examination under microscope to determine the type and number of non-metallic inclusions. Several charts now exist to rate the "oxide" and "slag" types of inclusions found.

3. *ASTM grain size* (*McQuaid Ehn*) — This is run on many steels. Although originally applied to carburizing steels, it has for many years been applied to medium and high carbon steels.

4. *Magnetic particle test* (*magnaflux*) — This test is applied to all magnetic aircraft grades and to certain automotive parts.

5. *Hardenability test* — The Jominy test is the most popular. Others include the Shepherd PF and PV tests, and special tests required by individual companies.

6. *Microstructure and decarburization* — Where machining and heat treating involve structure and decarburization, these tests are employed.

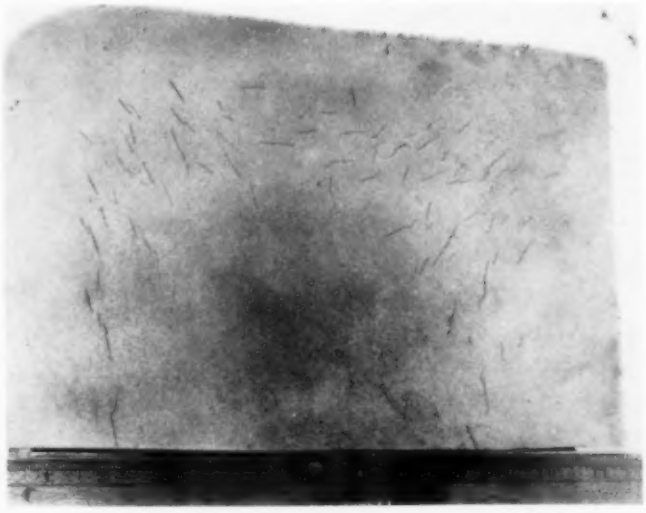
7. *Fracture tests for cleanliness* — This test is employed on tool steels and bearing steels in fully hardened condition when fracture reveals undesirable internal inclusions, voids or excessive carbide network.

8. *Mechanical tests* — Tensile, torsion, impact, tensile impact, torsion impact, fatigue, bend tests, creep, etc., are applied when required.

9. *Corrosion tests* — The stainless steels are often tested for their corrosion resistance under certain conditions as a measure of their quality. Typical of such tests are

a. Boiling nitric acid test.
b. Strauss embrittlement test.
c. Salt spray test.

Figure 10 — Typical "flakes" are shown in a 12-in. square AISI 4340 steel. These occurred in cooling after rolling.



DISCUSSION

PRESENTED BY

ELMER N. HULL, Metallurgical Engineer, Open Hearth, Ford Motor Co., Dearborn, Mich.

ROBERT SERGESON, Chief Metallurgical Engineer, Rotary Electric Steel Co., Detroit, Mich.

P. E. HAGLUND, Superintendent Raw Materials and Semi-Finished, Ford Motor Co., Dearborn, Mich.

H. F. LESSO, Open Hearth Control and Material Metallurgist, Great Lakes Steel Corp., Ecorse, Mich.

Elmer N. Hull: Regarding your remarks on track time in connection with electric furnace steel, would you mind telling us how long a track time that we should be able to get away with, on Type 3140; on 0.18 to 0.20 carbon types and on sheet steel?

Robert Sergeson: On 3140 steel, taking track time as length of time after last ingot is poured till after last ingot has been charged into the soaking pits, three hours should be a safe time on ingots of three to four

tons. Longer than this may cause cracking. The 0.18 to 0.20 carbon grades should be charged into soaking pits as soon as possible after they have solidified. On rimming steels we have allowed a large tonnage of large ingots (approximately 16,000 lb, to go cold, subsequently shipping them to other plants for rerolling. No complaints as to surface have been received.

We have also allowed 17½ x 18½ in. ingots (approximately 4600 lb) of rimming steel to go cold without encountering trouble. This is the smallest size ingot we can rim successfully.

P. E. Haglund: The electric furnace steels seem to be getting more than its share of criticism this evening. There is nothing of a controversial nature in it, but we have had a number of experiences with this type of steel, one of which I would like to bring to your attention. Our electric furnace sheet steel, given the same annealing treatment applied to our open hearth steel, invariably has a higher hardness, offering more resistance to deep drawing. Some metallurgists attribute this to nitrogen entirely. Personally I do not. What is your view on this peculiar condition Mr. Sergeson?

Robert Sergeson: I do not believe I can tell you. We think nitrogen has a great deal to do with it, but we have not had too much experience with that, but I believe from what we have been able to learn that if you lengthen your annealing cycle, and perhaps use a slightly higher annealing temperature you can help yourself on the electric furnace deep drawing quality.

H. F. Lesso: For approximately an eighteen month period, a record was maintained of ingot performance at the teeming platform and cold mill rejections due to physical properties. During that period of time, the geometric patterns as defined by the two curves were amazingly similar indicating some relationship.

As is generally understood, the rimming action on low carbon open steel must be reasonably vigorous to result in good clean skin characteristics and favorable ingot structure. When this rimming action has been permitted to continue for a pre-determined length of time, a cap is placed over the top of the ingot to arrest this action.

This capping operation has been found to be a critical operation, in that, early capping as well as delayed capping affect the ingot quality adversely. An ingot capped too early will tend to blow out under the cap, and this release of gas seriously disturbs the freezing pattern of the ingot through the resulting agitation. Such performance usually results in a double skin-core pattern. This dual line of segregation in an ingot has been found to contain a wider range of unfavorable chemistry than that found in an ingot not exhibiting this blowing performance. This is but one of numerous characteristics readily noted in the performance of an ingot of rimming steel which is directly related to the physical properties of the cold rolled product.

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

THE MILL MOTOR AFTER FORTY-FIVE YEARS

By S. S. BURNS
Crocker-Wheeler Electric Manufacturing Co.
Division of Elliott Co.
Ampere, N. J.

. . . . the new 600 series mill motor has already proved itself and is now specified on practically all orders for mill motors . . . .

▲ IT is well understood by everyone interested in steel mill motors that the new 600-series, as standardized by the AISE in 1947, offers the industry motors of the same dimensions as, and mechanically interchangeable with, the previous series, but with the next higher rating developed in each size, from the 602 with 7½ instead of 5 hp to the 618 with 200 instead of 150 hp.

It is probably not quite so well understood how this has been accomplished, or how it has been possible to so considerably reduce the overall size of a motor for a given rating with no increase in temperatures, and with definitely improved performance.

. Using to the full the accumulated experience of forty-five years since our company pioneered the first "steel-mill" motors and incorporating the up-to-the-minute ideas of the users, the new motors not only give better performance but include many improvements in details of manufacture and construction to improve accessibility, reduce maintenance and give maximum life.

In addition to the AISE standardized features which include among others the solid cylindrical roller bearing, improved pinion gear tooth design, liberal radius at shaft extension and smaller space; the following outline of mechanical and electrical features of these motors should demonstrate the definite advance over their bulkier predecessors which they replace:

1. Lower losses — higher efficiency.
2. More effective cooling.
3. Improved insulation.
4. Better commutating ability and greater overload commutating capacity.
5. Desirable accessibility.
6. Minimum maintenance.

The design of a motor, for a stated rating, temperature limitations, and overall performance, to go into the overall space previously occupied by a motor of only 3/4 or 2/3 the capacity entails the consideration of many factors involved in obtaining these features. The following discussion will serve to show how the new design is possible and why it is superior.

HEATING AND VENTILATION

The temperature rise of a motor depends upon the magnitude of the losses themselves, the thermal capacity of the motor parts, and the effectiveness of heat transfer and dissipation.

1. The losses in the smaller frame for the same output as its larger predecessor have even been reduced by incorporating these design features.

a. An armature core volume (D^2L), equal to that of the large frame, has been made possible by the use of shorter bearings, shorter pole heights, and conservation of the internal space. An armature coil insulation with better space factor has allowed space for more copper. Elimination of an armature sleeve or quill has made possible the retention of full effective magnetic section while allowing the addition of axial ventilating ducts. The full utilization of the field space has permitted the desirable full number of interpoles. Interpole coil and series coil copper are in general a little larger in cross-section, offsetting the larger number of turns of four interpoles vs two.

The over-all result is an equal or slightly reduced total of normal copper and iron losses for a given rating.

b. The loss due to the uneven distribution of current in the armature conductors, or what is more commonly known as the eddy-current loss, has been reduced by laminating the conductors. A reduction in this loss is particularly effective since it appears principally in the slot portion. However, the degree of laminating has been limited so as not to affect space factor, heat conductivity and commutation.

c. The improved commutation afforded by the full complement of commutating poles and multiflex

brushes tend to reduce sparking under difficult operating conditions of load swings and high peak loads. A reduction in the degree of sparking results in reduced heating of the brushes and commutator. The lower commutator temperature lessens the heat flow by conduction up through the commutator necks and into the armature coils.

d. Brush friction has not changed to any extent because commutator dimensions, brush areas and brush friction are approximately the same, rating for rating. Bearing friction is considerably reduced in the new straight roller bearing.

Although the core bolts are close to the inner periphery of the core punching, they still lie in a weak magnetic field. In order to avoid additional heating, the core bolts are completely insulated to eliminate eddy currents through the core steel and end flanges.

The addition of fan blades on the rear armature flange has added slightly to the windage losses, but effect on total losses is negligible.

heat dissipation from the armature of a totally enclosed machine would be a help at this point. As the temperatures of the armature conductors and armature core iron increase due to their losses, a part of the heat proportional to the rate of temperature rise is stored in the thermal capacities of the copper and the iron. The remainder of the heat flows at a rate proportional to the instantaneous temperature difference of the copper and iron, the direction of which is from the hotter to the colder body. Simultaneously, there is a flow of heat through the iron to its surfaces, and through the copper across the insulation to its surfaces. The surrounding inside air picks up the heat from the surfaces and delivers it to the inner frame and pole surfaces by conduction across an adhering air film. Heat is also radiated from armature surfaces to poles and frame. The heat then flows by conduction along the poles and across the frame to the outer surface. The rates of heat flow per unit area for the above are directly proportional to the specific thermal conductivity and the instantaneous

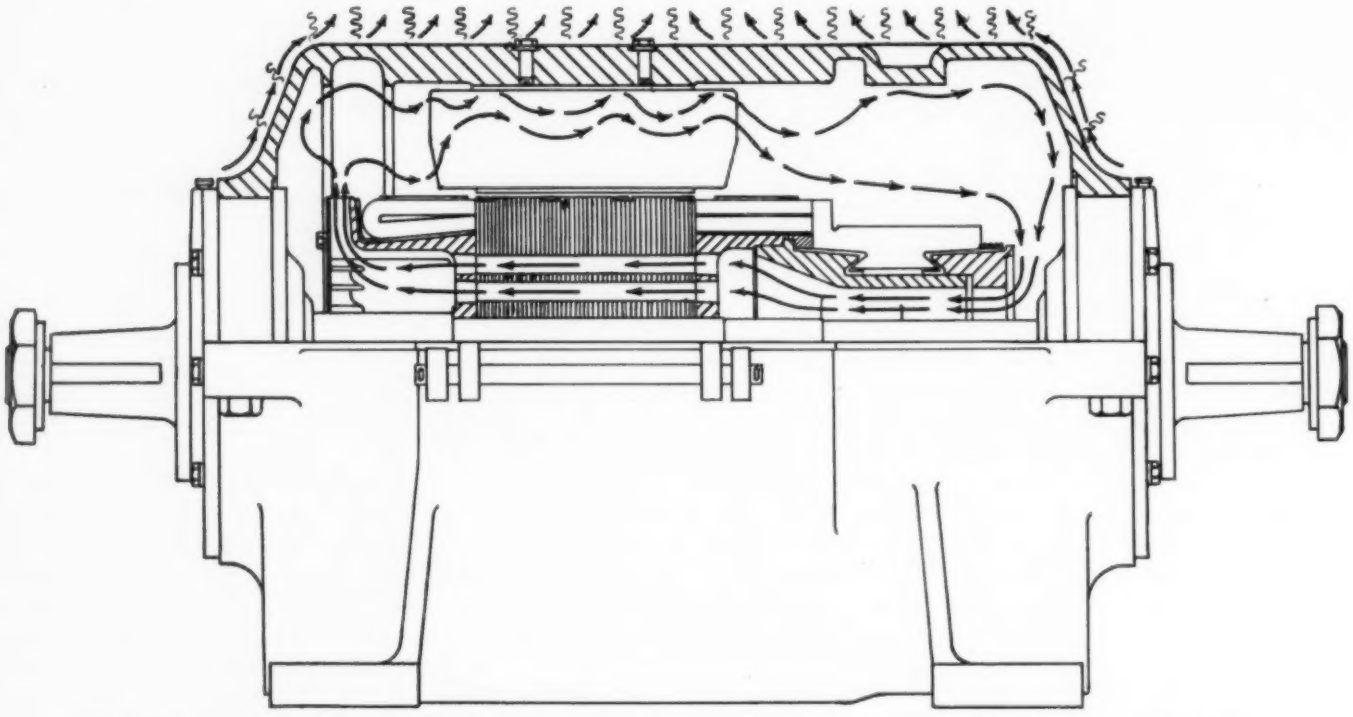


Figure 1 — The internal air circulation of the totally enclosed mill motor effectively removes the heat.

2. For a given loss, the temperature rise of totally-enclosed short-time ratings depends principally on the thermal capacity. Thermal capacity is the ability of a motor to store heat and is proportional to the weights of the component parts and to their respective specific heats. For example, only 3.8 watts stored in one pound of copper for one hour will give 75 C rise. Because the weight and proportions of the machine have remained about the same, rating for rating, except for the poles and yoke which are not of too great importance in short-time ratings, the thermal capacity has not changed to any appreciable extent.

3. However, totally-enclosed short-time ratings also depend to a small degree upon the ability of the motor to dissipate heat, and this factor increases in importance as the rating time increases.

A brief description of the heat storage, heat flow, and

temperature difference between the hotter and colder body, and inversely proportional to the length of the heat path. Finally, the heat is dissipated from the frame by radiation and natural convection at a rate which is approximately proportional to the temperature rise. The simultaneous occurance of heat generation, heat storage and heat dissipation results in a temperature rise following a complicated exponential curve. For short-time operation the rate of heat generation is greater than the rate of heat dissipation, and the difference is stored in the machine. Final temperatures are reached in continuous operation when the rate of heat dissipation equals the rate of heat generation. A similar analysis can be made for the fields except here conduction directly from the pole core to the frame plays a vital part in heat dissipation.

Totally-enclosed continuous ratings depend only upon

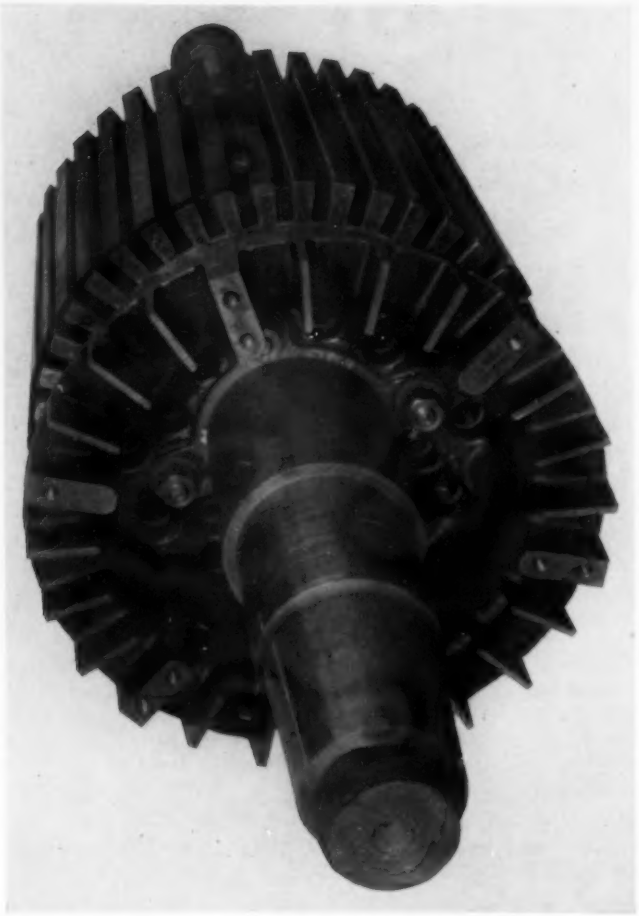


Figure 2 — The rear view of the armature shows the armature fan without the shroud and two rings of axial air ducts.

the dissipation of heat from the frame. In order to improve the rate of heat dissipation from the frame, it is necessary to increase the flow of heat from the heat source to the internal air and from the internal air to the inner surface of the frame. Therefore, the following features were incorporated: Thorough circulation of internal air with maximum heat transfer from the heated surfaces, and minimum thermal drop from internal air to frame. The final aim is to make the frame as hot as possible without exceeding the permissible temperature limits of the various parts of the machine.

As previously mentioned, heat is dissipated from the frame by natural convection and radiation at a rate which is approximately proportional to the temperature rise. In general, the dissipation by free convection is proportional to the five-fourths power of the temperature rise above ambient air, and the dissipation by radiation is proportional to the difference between the fourth power of the absolute temperature of the frame and the fourth power of the absolute temperature of the surrounding walls. For example, a black horizontal surface plate with an increase of surface temperature rise from 40 to 50 C over a 40 C ambient and surrounding walls will give about a 33 per cent increase in watts dissipated by radiation and free convection as compared to the 25 per cent increase of surface temperature rise.

The internal circulation for the totally-enclosed machine is shown in Figure 1. The generally used shrouded armature fan (Figure 2 shows the armature fan without shroud and the two rings of the axial core ducts) forces the air to flow between the commutator spider and the shaft, through the axial air ducts, through the fan along the inner surface of the frame, and parallel branches through the spaces between the field coils and along the armature outside surfaces, and finally over the commutator to complete the air circuit. The rotation of the armature increases the static pressure required to move a given volume of air, but assists by its stirring action in increasing the heat transfer from its surface to the axial ducts and to the air gap. The forced air movement increases the heat transfer coefficient from the armature outside surfaces, from the armature axial duct surfaces, from the commutator surfaces, from the field coil surfaces, and to the inner surfaces of the frame. Therefore, for a given number of watts generated, the temperature difference between the inside of the machine and the inner frame surface is reduced. This in effect gives higher outside frame temperatures, and consequently a greater heat dissipation.

Other important features which assist in heat dissipation are: fan blades integral with the flange as shown in Figure 2 to permit conduction of heat from the core and the rear armature heads; and use of a special compound of especially high heat conductivity for brushing between layers and for filling of interpole and field coils to form a solid mass.

Therefore, the combination of reduced losses, improved air circulation, and increased heat transfer and heat conductivity coefficients gives higher frame surface temperatures and consequently increased heat dissipation which more than compensates for the reduction in frame surface area.

Figure 3 — A double fan is used for the self-ventilated motor.

In the actual problem of the size smaller frame we are required to dissipate almost the same total watts from a frame area 16 per cent smaller on the average. This then requires in the neighborhood of 19 per cent more watts dissipated from each sq in., and assuming 40 C ambient and surrounding walls, this in turn requires an increase in frame temperature rise of approximately 13 per cent.

Comparative tests on old and new motors demonstrate that this is a fact. For example, tests show that when operated at the same continuous output the frame surface of the new 610 actually has a temperature rise about 16 per cent higher than that of the old 12W50 while maintaining the same temperature rise of the internal windings.

For the relatively infrequent cases where a protected self-ventilated motor is desired, a double fan as shown in Figure 3 is attached to the rear coil support. This forces the air to flow through the motor in two general independent parallel paths. One air path is from the external openings at the commutator end of frame, through the ducts between the commutator spider and shaft, through the axial air ducts; under the rear coil support; up through the outer fan, and finally, discharge directly through the radial openings in the frame. The other path is from external openings at the commutator end of frame, over the commutator, over the surface of the armature in parallel with air flow between the field coils, through the inner fan, and finally, as above, discharge directly through the radial openings in the frame. The reduced losses coupled with the effective forced circulation developed by the double fan have made it feasible to obtain the same rating in a smaller frame.

COMMUTATION

The features which make it possible to improve the commutating quality, to increase the overload commutating capacity, and reduce brush and commutator wear in the new line are:

1. The full complement of interpoles, as pointed out previously, is not as susceptible to the effects of saturation as half the number of interpoles. During excessive overloads, saturation results in an incomplete compensation of the armature reactance voltage with consequent tendency to spark. Also, the time constant of the full number of interpoles is less, and therefore with rapidly changing loads the lag of the interpole flux behind the armature current is reduced. The faster response reduces the possibility of sparking.

Figure 4 — Shown is a typical armature coil in various stages of insulation application.

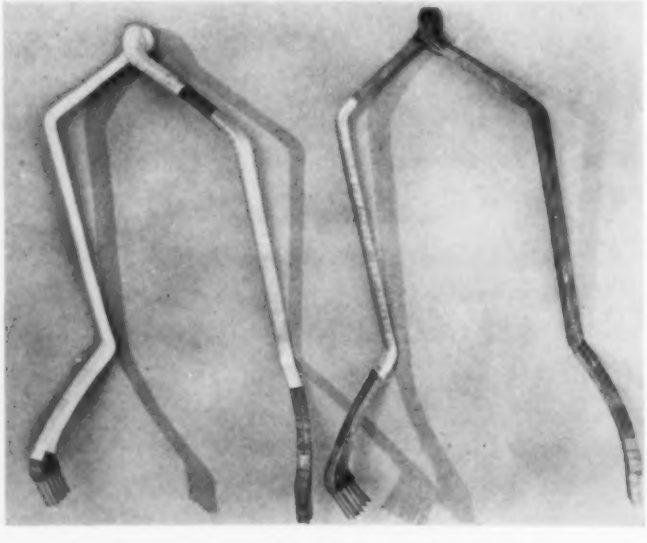


Figure 5 — The details of the rear coil support insulation of the armature are shown in the photograph.

2. The newly designed arch-bound commutator maintains a smooth surface over wide ranges of temperature and speed. Longer, high-strength commutator bolts provide the required spring characteristics for centrifugal and thermal stresses.

3. The multiflex or split-type brushes consist of two separate brushes held together in the brush box to permit necessary independent action. This twin brush provides a much larger number of contact points on the commutator than one solid brush of the same total width and thickness. Split brush construction tends to keep at least part of the brush on the commutator at all times, where slight roughness or eccentricity may cause a complete break with one piece brush. Insufficient contact points will give localized high current densities which result in excessive temperatures with consequent burning of brush and commutator.

The split increases cross resistance with a direct desirable effect on commutation.

The lower inertia of each brush of the split-type allows for faster response to follow irregularities on the commutator. This avoids selective brush action with consequent overloading and burning.

4. Each brush is contained in a complete box to insure completely independent action. The partitions also add rigidity to the brushholder enabling it to withstand abnormally high temperatures without distortion and therefore assist in insuring accurate brush box dimensions and brush fit in the box.

5. The other important features incorporated in the new line and used in the predecessors are given below for completeness:

Approximately the same commutator diameter and surface area, and total brush area on the basis of hp rating.

Completely symmetrical armature winding without "dead" coils. This improves commutation, particularly in field weakened motors.

Laminated interpoles reduce the eddy currents in the pole body. This reduces the lag of the interpole flux behind the interpole current and so minimizes the tendency for sparking.

The interpole face is designed to give proper flux distribution over the commutating zone.

Regulated heat treatments or curing cycles with graduated tightenings of the commutator result in a permanent set of the mica with no future slippage.

Accurate spacing and alinement of commutator bars and brushes, and correct line-up of core slot with commutator bar, are incorporated in order that the brushes shall come in the correct neutral position at each stud and to insure interchangeability of armatures with fixed brush position.

Brushholder and brush pressure are designed for uniform pressure and firm contact even in the presence of commutator surface irregularities, and for ease of adjustment in commutator wear.

INSULATION

The insulating materials and their application should be such as to give minimum maintenance and maximum life under the severe conditions of excessive temperatures, expansion and contraction forces, vibration, shock, and exposure to moisture, dust, oil and chemical fumes. In addition insulation should give maximum space factor along with high heat conductivity.

The essential features of the insulating materials and the application required to satisfactorily withstand the conditions and have the characteristics given above have been incorporated in the new line and are given below. The majority of these features have been developed and improved by experience to achieve the aim of "less maintenance and longer life."

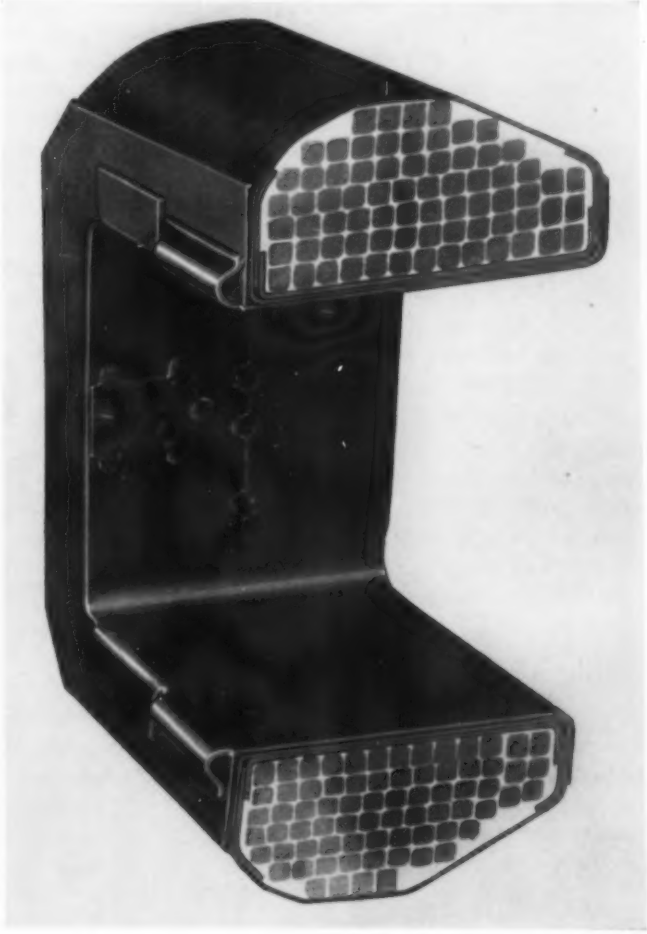
1. *Armature coil insulation* — The armature coils are subject to the greatest abuse, therefore, very conservative design, along with the best materials and manufacturing methods must be adopted. Figure 4 shows a typical armature coil in the various stages of insulation application.

The first layers of insulation are subject to the maximum temperatures and therefore must have particularly high thermal endurance and chemical stability. Silicone-bonded double glass covering on each conductor strand serves this purpose well. Possible injury to this insulation at sharp "U"s on coil knuckles is taken care of by taping alternate coil noses with very flexible, strong glass backed mica tape. Suitable varnish is applied to fill all the interstices between the fibers, and baked to cure and harden throughout. The straight portion of the coil group is then hot pressed into a solid mass. The application of a number of wraps of glass backed mica tape extending continuously around the bends for added protection at these stress points and through the slot portion, provides the principal ground insulation. Tape is particularly desirable because of its ability to withstand the handling and abuse of winding without injury. Each lead is insulated with glass tape up to the commutator necks to prevent a short due to the possible accumulation of conducting foreign material between the leads. Asbestos filled bakelite strips are placed on the straight portion to act principally as an added protection against pressure from core bands and slot wedges. Multi-turn coils have, in addition, mica separators between turns at the heads and around the rear nose, where the coil is subject to the greatest abuse during winding in the armature. The coil group is then completely wrapped with glass tape, and suitable varnish is applied to give a hard, smooth surface for winding and to provide moisture and oil resistance.

The above procedures in conjunction with accurately shaped coils, rounded tooth tips, and rounded edges of core insure a satisfactory winding without strains and injury. The winding fits tightly in the slot to prevent movement and for high heat conductivity.

2. *Armature winding insulation* — Figure 5 shows the completed insulation in the rear coil support or armature flange. This insulation, which covers the entire surface and inner edge of the support, consists of a solid matted structure of strips of mica cloth and glass tape, thoroughly painted with varnish. This provides the necessary insulation and creepage distance to ground, and gives a high heat conductivity. Also, the flange insulation comes flush with the bottom of the slot to

Figure 6 — Cross section of a typical series coil with shell.



prevent coil pressure at slot corners. Similar insulation is provided for the front coil support.

Between the upper and lower coil layers at the rear and front heads, layers of heavy mica cloth are placed in a continuous ring. This insulation is particularly effective in protecting the top surface of the layer from chafing as the upper layer is wound into place, and to provide cushioning as head bands are applied.

Layers of mica cloth and glass tape are applied under head and core bands to prevent abrasion, provide cushioning, and afford protection against the soldering heat during banding. Under vibration and centrifugal forces with high temperatures, these protective layers prevent chafing and consequent breakdown.

After the armature is completely wound and banded it is baked, rolled hot in varnish which is resistant to oil and moisture, baked, rolled in varnish and baked again.

3. *Commutator insulation* — Mica collars and sections continue the high quality used in the previous line.

In order to avoid accumulation of foreign material in back of the commutator and under the front heads, a special compound is used to fill the void between the commutator spider and the layer insulation under the front armature winding extension. This solid mass prevents foreign matter from entering this region and causing possible shorts between commutator bars.

A chamfer at the ends of the commutator bars is filled in with an oil resistant cement and baked on to seal against entry of oil and dirt between bar and collar surfaces.

The front mica collar extension provides a long creepage path, and is corded and painted with coil resistant varnish to prevent flaking and movement.

4. *Interpole and field coil insulation* — Interpole and field coils are wound with double glass covered wire. The conductor at each inside corner, the most vulnerable spot, is given added protection by a mica tape wrap. A thermosetting varnish is thoroughly brushed on each layer while winding. The viscosity of this compound during brushing is low enough for the flow to completely fill all the interstices between the glass fibers and between adjacent wires, but not low enough to run off. Its stickiness along with the correct viscosity assures adhesion in a thick uniform layer to the glass wire, and after a press bake gives a hard and solid mass.

The use of back turns brings the inside lead out without any cross over. Each lead is brazed on to the end turn after the coil end has been securely held by a clip soldered to the extra insulated adjacent turn. The lead joints are insulated following the removal of sharp edges and projections to avoid injury to the adjacent insulation. Layers of mica cloth are used to separate the shunt and series winding. Leads are offset to facilitate connections and to avoid possible shorts.

Mica cloth in layers is applied to the insides, and top and bottom of the coil in the form of coil size sheets, cut to fit and overlap. The unbroken mica sheets provide ground insulation where needed, and are not applied on the outside of coil where they are not needed and where they would obstruct heat transmission. A varnish compound is used to fill all the spaces and so form a smooth contour for the final glass taping.

The coil is then assembled on the steel shell, and after filling all voids between coil and shell with a varnish compound, the coil and shell are placed in a special form and a power press is used to form the shell over the steel washer on the coil. The coil and shell unit is then baked while under the pressure of this form. The form is removed and the coil and shell unit is dipped while hot in a varnish which is resistant to oil and moisture, and then air dried. This assembly results in a tight, rigid coil on the steel shell where there can never be any relative movement.

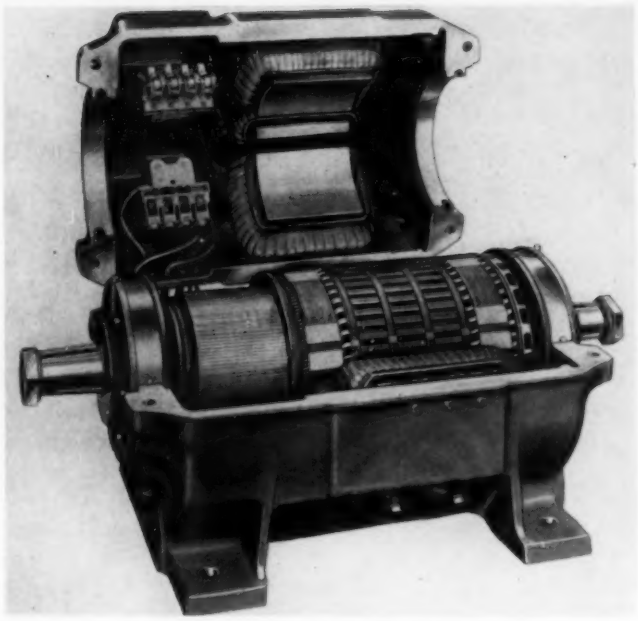


Figure 7 — The new 600-series mill motor has a very compact design.

Figure 6 shows a cross-section of a typical series coil with shell showing the relationship of winding insulation and shell. The construction, materials and processing employed afford maximum protection against electrical failure and mechanical injury.

MECHANICAL FEATURES

Figure 7 shows the compact design with full complement of interpoles of a typical 600-series mill motor. Figure 8 shows a complete armature with mounted bearing housings and integral armature fan.

1. *Bearing and bearing mounting* — The design of the cylindrical roller bearing replacing the former long type spiral bearing allows higher radial load capacity and withstands heavier momentary overloads and greater shock loads without failure. It also permits shortening of the housing with saving in internal space, and consequently more room for active material. The lips of the races, backed up by the shaft sleeve and bearing cap to prevent distortion, can carry thrust equal to about 10 per cent of the radial capacity which is ample for all usual coupled or geared drives. Thrust bearings are supplied for special thrust applications such as bevel gear and vertical drives.

The tapered shaft extensions correspond to the next s naller frame size to permit interchangeability; e.g. the 50-hp motor in the new line has the same shaft extension as the 35-hp in the former line. The shortened distance between pinion and bearing, the liberal radius

at large end of shaft taper, and the same shaft diameter at bearing with greater bearing capacity allows the use of the smaller tapered shaft extension, rating for rating, as approved and standardized by the AISE.

A locking plate is used to lock the shaft nut.

A grease fitting at the outside diameter of the bearing housing provides easy accessibility when a gear enclosure is used. Annular grooves, along with hard grease in the shaft seals, give good protection against entrance of moisture and dirt. When new grease is pressed into the housing, the excess is forced from the bearing against a flinger which throws the grease by centrifugal action into an annular chamber of the housing. The grease drains into a sump chamber where it can easily be removed. This flinger in conjunction with grooves in the housing prevent the grease thrown by the bearing from entering the inside of the machine where damage to the commutator, brushes and winding might result. An accessible tapped fitting at bottom of bearing cap allows for drainage and flushing.

The outer bearing cap is removable and permits inspection of the bearing without complete removal of housing. The outer race, rollers and cage are separable from the inner race and can be easily removed for cleaning.

The inner race is shrunk on the shaft. In back of the inner race is a collar which carries the flinger and has a groove on its outer surface. This groove can accommodate a bearing puller for pulling off the inner race and ring.

2. *Armature* — Armature core laminations of low loss steel are stacked on a mandrel and bolted up between flanges. The bolted core is removed from the mandrel and the shaft is then pressed into the core and keyed. The interference at core and shaft fit is sufficient to carry maximum torques without depending on the key. A group of laminations, spotwelded together, are placed between core and flange to provide support for the teeth thus eliminating need for end plate fingers and permitting flange insulation to be applied right up to the core.

In order to secure the coil heads firmly to prevent movement, high strength, non-magnetic special alloy steel banding wire is "under-run." "Under-running" provides uniform tightness of individual band wires and holds the armature coils firmly down on the support flanges at all speeds. A sufficient number of band clips is firmly anchored and soldered to banding wire by means of high temperature, high strength solder to give maximum security at high speeds and high temperatures.

In line with the preference of the majority of users, slot wedges are now used in place of core bands on the larger armatures. On the smaller cores with shallower slots, the use of wedges would appreciably reduce the space for active material and bands have accordingly been retained. The non-magnetic high resistivity steel wire affords an increase in safety factor over the material previously used. The wire is wrapped with uniform tension and band clips are applied similarly to the head band. The proper location of a suitable number of core band clips assists in reducing the losses due to the main field flux.

3. *Commutator* — Commutator bars are deeper, rating for rating, allowing for extra wearing depth. The commutator spider is pressed and keyed on the shaft on the same key as used for the core, with a centering fit on the front armature flange. The commutator assembly remains a rigid part of the armature when shaft is removed.

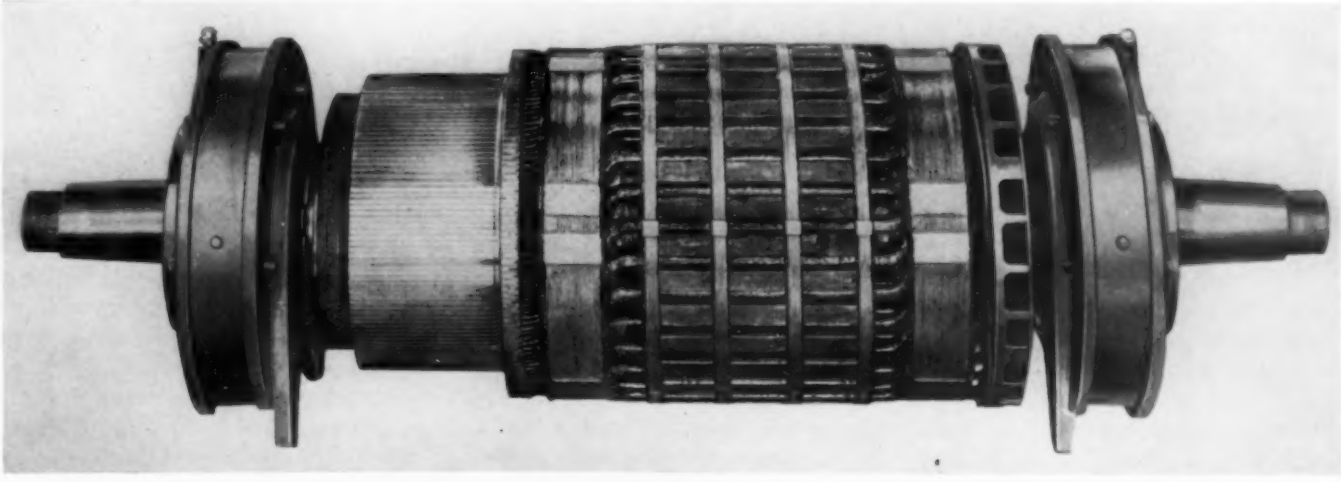
The special high temperature, high strength solder used to connect armature coils to commutator bars is an improvement.

The general use of an integral armature fan of the same diameter as the armature is very desirable because of ease of handling, relative safety from injury and consequent outage, and reduced inertia.

An unbalanced armature gives injurious and dangerous commutation with possible damage to bearings and connected gearing and equipment. Dynamic-balancing machines are used to limit the unbalance to within an acceptable limit.

The armature construction permits shaft removal without disturbing the winding. A collar, notched over core bolts and washers so that no force is transmitted through the core bolts, is placed in contact with rear coil support. With the collar acting as a stationary backing-up surface, the shaft is pressed out from the

Figure 8 — The armature of the motor has mounted bearing housings and an integral armature fan.



armature assembly. The rabbet fit, between front coils support and commutator spider, maintains the core and commutator as an integral assembly after shaft removal.

When pressing the shaft into the core and commutator assembly, a collar in contact with the commutator spider and not the bars is used as a backing-up surface.

The commutator may be removed from the shaft and front coil support after the armature conductors are unsoldered.

4. *Brushholder* — Except for the partitions in the brushholder, previously mentioned, all of the other features such as rounded pressure fingers, non-corrosive bronze springs, means of adjusting spring pressure, and heavily shunted pressure finger and springs have been retained since they have proved most satisfactory. The pivot pins for the pressure fingers are supported in stainless steel bushings.

The method of supporting brushholders on the 610 and larger frames has been revised for maximum accessibility with new style frame openings.

5. *Field coils* — The steel shells on which the field coils are mounted have been redesigned to be more economical of space which was formerly unused at both top and bottom of field coils. The coil and shell are firmly clamped between the pole horns and the frame. Special tab design allows the clamping pressure to be distributed over the shell, and thus to the entire coil without localized pressure areas which might damage the coil insulation.

6. *Enclosures* — Instead of the one large hinged cover on the top opening, which is sometimes objectionable because of the extra head room required, smaller covers on two openings on the 45 degree are used on frame 610 and larger, which incidentally reverts back to the design of the original mill motor of 45 years ago. These openings permit easy access to the commutator, and either opening can be adapted for forced ventilation. The covers cannot be removed unless a special pin at pivot is removed.

Besides the commutator hand holes, provisions are made for forced ventilation from the front bottom opening of the frame. For discharge of the air, a self-closing door can be provided at the opening at the end of the frame opposite the commutator, below the shaft.

For the occasional applications which require self-ventilation or protected, forced ventilation, the frame can be supplied with additional openings for air inlet and discharge.

7. *Frames* — All frames are split, and all except frames 614 and larger are hinged. The general frame shape is a reversion of the first alpha W design. Drain holes at each end of frame allow easy drainage of accumulated moisture.

CONCLUSION

This paper gives a fairly complete picture of how a new motor of radically reduced size, which at the same time is a better motor than previous good motors has been produced.

It is not believed that the industry will be looking for any further similar step in the near future, but inevitable progress in materials, methods, and ideas will in due time offer the possibility of another step in the continuing improvement of motor weight and space efficiency. At the present time it appears that such an advance must follow the general acceptance of higher temperatures and the solution of all the parallel problems of insulation, expansion, electrical and mechanical connections, lubrication and commutation. The answers to these questions may well form the substance of a similar paper ten or twenty years hence.

DISCUSSION

PRESENTED BY

FRANK W. CRAMER, Electrical Engineer, Carnegie-Illinois Steel Corp., Pittsburgh, Pa. (Now Consulting Engineer, Elliott Co., Pittsburgh, Pa.)

A. H. GRAHAM, Manager, D-C Armored Motor Engineering Division, General Electric Co., Erie, Pa.

JAMES FARRINGTON, Electrical Superintendent, Wheeling Steel Corp., Steubenville, Ohio

S. S. BURNS, Crocker-Wheeler Electric Manufacturing Co., Division of Elliott Co., Ampere, N. J.

Frank W. Cramer: Four or five years ago when this new line of motors was conceived, a questionnaire was sent to a great many of our members asking what they would like in the new motor. One of the few unanimous answers we received was that the temperature rise should not be greater than that of the motors we were then using, which gave the motor designers a problem to build about 50 per cent more horsepower into the existing frames.

On this particular point, there was a great deal of doubt among our membership as to whether or not this could be done. Since that time, several of the manufacturers have built a complete line of motors, and perhaps the best proof of that point is the test results on the completed motors which in every case have met the temperature rise and also the efficiencies. In every case, we believe they are making a better motor than the old motor.

This paper is very timely in the series of papers we have had on this motor. He shows us how his company in particular has developed the various details to get this increased horsepower and torque into the new motor. They have taken advantage of the space factor. The designer had only so much space to start with and into that space he had to house the new design, and it has been utilized more efficiently than in the old motor.

There are new insulations that did not exist twenty years ago. He described the use of silicone and the glass tapes in the motor. There are also better steels available today. Finally, he talked about the commutator. They can build better commutators today than they could build twenty years ago.

Putting all these together, it has resulted in this new mill motor which, as I mentioned before, has approximately 50 per cent more horsepower built into the same-

sized motor-frame. What the future is going to provide, I am not going to predict, but this will be in the line of progress. Perhaps twenty years from now, as he suggested, we can build another 50 per cent into this framework. That is too far in the future to comment on.

As a proof that this motor is a success and has been accepted by our membership, we find that during 1948 approximately 75 per cent of all the mill type motors sold were of the new-frame type, and I have been informed that in 1949 this percentage is running even higher; possibly 85 per cent of all the mill motors built are in the new frame. We have a good motor in this new type and the percentage of use is going to keep on increasing until it has replaced the superseded types in use for the past twenty years.

I would like the author to expand his discussion on how the designer was able to design the shaft without overstressing it.

A. H. Graham: Dr. Burns has given a very complete discussion of the basic design ideas which made the 600 line of mill motors possible. This new 600 line of motors is rapidly becoming a veteran in the steel industry. Some sizes of this new standard motor have been in service for as long as three years and the number in service is well over two thousand, counting only those produced by my company. I might say here that it is almost exactly three and a half years since some of you people visited Erie and took a look at the first 600 motor.

The record of these motors in service has been much better, both electrically and mechanically, than could have been hoped for at the beginning of the development; however, it should be recognized that the most important recommendation, or condemnation, of a motor, is that of the user, the steel industry in this case, rather than our opinion as designers and manufacturers of motors.

We have preferred in the design of our mill motors to place the armature punchings, the armature heads, and the commutator assembly on a sleeve or armature spider as it is sometimes called. The armature shaft is pressed into the spider. With this construction there is absolutely no chance of disturbing the armature and the commutator when it is necessary to replace a shaft. It is possible that a press fit, one part of which is composed of laminations, will be more difficult to assemble and disassemble than one composed entirely of solid machined parts. We believe this latter arrangement provides for easier shaft replacement which results in lower costs. With this spider type of construction we have still been able to provide adequate steel in the armature core to carry the magnetic flux.

The 600 line of motors has the same tapered shaft extension as the corresponding size or number motor frame in the previous standardization. This was necessary in order to provide the maximum interchangeability between the new and the old standard motors.

From a design standpoint, although the stresses in the taper portion of the shaft are higher than for the older motors, they are within reasonable limits. The size of the shaft through the bearing on the 600 line of motors is greater than the shaft size for the corresponding frame size in the older motors. This provides a factor of safety in this portion of the shaft equal to or greater than the older motors had. Again, however, the best indication of whether this thinking is correct is the service that the motors give the steel industry.

Of the more than 2000 motors which we have in service, there have been only two shaft failures. Both of these failures were on the tapered portion of the shaft. We feel relatively sure that both of these failures were due to misalinement between the driven shaft and the motor shaft. Successful operation has been obtained on both jobs since the shafts were replaced.

It is felt that only two failures in over 2000 motors is sufficient proof that the standard taper shaft on the new motors is adequate.

We hope that the splendid discussion given by Dr. Burns of the design features of the 600 line of mill motors and the service record of more than 2000 of our motors over a period of 3 years will give you even greater confidence in your new 600 line of mill motors.

James Farrington: I am going to give you a little past history of motors used in mills in 1896, as it occurred to me as I listened to this paper that there are some in the audience I know who can go back that far. I am going to start with what we had for the first motor, which we used in the mill, which was decidedly not a mill type motor. This was one of the General Electric Company's LWP's, (little waterproof type), with the windings fastened to the commutator on the top with screws. There was no insulation between these screws so you could readily see the trouble we had in preventing shorts.

The General Electric Company brought out, in about 1898, their CO type of motor which was completely enclosed and resembled the present day mill type motor. They started to manufacture the MD-100 series in February, 1907.

The General Electric MD-400 series was started in 1925 but standard horsepower and speed ratings were not established by AISE until April, 1926. The MD-600 line was started in 1943. However, it was not presented to the AISE committee until its meeting at Erie Works in May, 1946.

The Westinghouse Company in 1886 brought out the multi-polar open type motor with which a lot of you are familiar, and we still have some of them in service, and my first introduction to them was in 1896. Electrically I think, the man who designed them possibly never thought of using it as a mill motor, but mostly as a generator.

In 1892 the Westinghouse Company were building motors for street car service with axle bearings but no feet, and were designated 48-25 hp, 47-50 hp, and 76-75 hp. They put feet on this type of motors and we had our first mill type motor. The laminations were keyed to the armature shaft, making it impossible to replace a broken shaft without dismantling the armature.

They brought the type K motor out in 1898 in horsepower from 1 to 20 and was completely enclosed and well made. The Westinghouse Company in 1909 brought out their first mill type motor designed MT for hard mill and crane service, and were furnished with or without axle bearings. In 1915 they started building the MC series in frames 31 to 181 which was an improvement over the MT series as they were equipped with the first interpole field coils.

The Westinghouse brought out their MCLA type motor in 1929 and their MCSA in 1939. These were interchangeable mechanically with the General Electric 400 series. They started supplying their MC-600 series AISE standard mill motor in 1947.

The Crocker-Wheeler Co. in 1894 brought out their first Form K and Form M motors used in mill service. The Crocker-Wheeler Co. in 1904 brought out their Form W series, the first mill type motor ever to be designed and placed on the market for mill service, and called it auxiliary mill motor. In 1932 they developed and placed on the market their 400 series, which was interchangeable mechanically with other manufacturers of the 400 series. In 1949 the Crocker-Wheeler Electric Co. placed their 600 series motor on the market.

I had the pleasure of witnessing the test of the first Westinghouse mill type motor along with several other independent steel mill engineers, and from that group at that meeting twenty-seven of us started this Association. We had assembled out at East Pittsburgh because we, as independents, were not allowed to associate with the U. S. Steel Corp. engineers, so we had to have a little group by ourselves, and Westinghouse Co. invited us out to their East Pittsburgh works. I firmly believe that the designer of the mill type motor must have had some experience in the steel mills, because he built a motor that he called 25 horsepower from which we could easily get 40 to 45. The present 600 series is sold as a 25 horsepower, but I do not know whether we can get 26 or 27 hp. As a matter of fact, you get what you pay for, and no more. So now we have about fifty-seven varieties. We have all of the types of motors, and our experience so far with all of them has been very gratifying.

One special feature that the engineers brought out in the 600 series is that it can go in the same space as the older, previous types, but with an increase in horsepower, and due to the change of product, or change of manufacture, or increased tonnage, that feature is going to be a very much longed for blessing, to be able to replace an overloaded motor with a modern one of much larger capacity.

S. S. Burns: Mr. Cramer's comments in general demonstrate the fact that the new motors meet their ratings. His emphasis on some of the details of materials, design and construction features which make this possible substantiate the author's remarks.

In reply to Mr. Cramer's question as to factor of safety of the shaft, detailed calculations in our design records show that the large factor of safety has been maintained in the new motor.

The total stress depends upon the combined torsional stress and bending stress. The shortened distance between pinion load and bearing center in the new design has appreciably reduced the bending moment, which coupled with a shaft diameter at the bearing equal to the old frame, horsepower for horsepower, has given a lower stress at the bearing.

Note the difference in bending moment arm between the equally rated W610 and the SW50 (the old frame) as shown in the layout of the W610 shaft extension and bearing location superimposed on the SW50 shaft extension and its bearing location (Figure 9). The stress at the bearing due to the combined torsional and bending stresses, based on five times rated torque, is 6300 psi for the W610 as compared to 8000 psi for the SW50. This difference is typical of all frames.

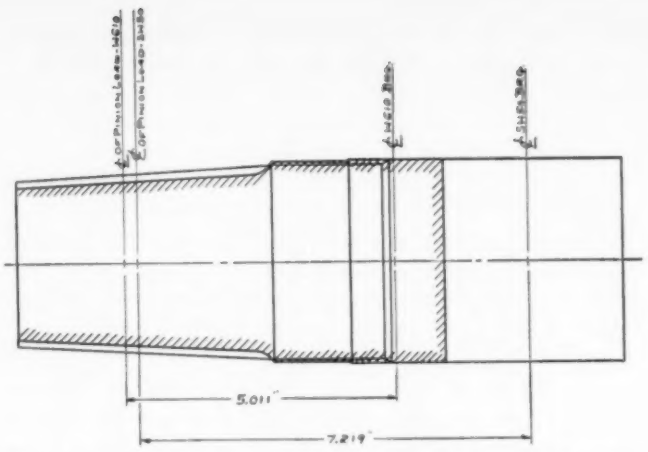


Figure 9 — Comparison of shaft extension and bearing location for the size W610 and SW50 mill motor. The outline of the W610 is shown by the cross hatching. The outline of the SW50 is shown by the straight solid line. Both motors are rated 50 hp at 500 rpm.

The fillet of 7/16 in. at large end of shaft extension of the W610 increases the stress concentration factor. However, its short bending moment as compared to that of the SW50 bearing center gives a maximum stress which is no greater than that of the SW50.

Although the stresses in the tapered extension are slightly higher in the new motor, they are not critical and are not the maximum stresses since the bending moments in this portion of the shaft is relatively small.

The facts, therefore, show that despire the increased load for the same size shaft projection, the new design succeeds in keeping the maximum stress to just about the same value as in the old motor line, and that this value has a large factor of safety. Accordingly the new motors will be as completely free from shaft failures as the old ones.

With reference to Mr. Graham's discussion of shaft replacement, it is a fact that our original mill motor line (Form W), which is still being built today, has proven for over a period of forty years, the satisfactory replacement of shafts in cores mounted directly on the shafts. This is not a matter of opinion, but of fact, and is the reason why the new motors have the benefit of additional magnetic core section and more axial air ducts, both of which are most valuable.

Mr. Farrington's review of the past history of the mill motor is very interesting. It is also of interest to note than a great number of motors of our company's original non-interpole Crocker-Wheeler design are right now in active use; and that there are users who have a well-based opinion in favor of these very plain and simple motors for particular applications.

Mr. Farrington's jokingly expressed doubts about the excess capacity of the 600 Series, have, of course, no basis of fact. This has been thoroughly explained in the paper, and it seems proper at this point to emphasize the fact that rating for rating there is more active material than in the previous line. This coupled with definitely improved internal air circulation should dispel any doubts as to the capabilities of the 600 Series motor. Continued operating experience will, once and for all, remove the last traces of any lingering doubts.

AISE STANDARD NO. 8

(TENTATIVE)

CRANE WIRING STANDARDS

OCTOBER, 1949

FOREWORD

. . . . The following proposed standard represents a great deal of exhaustive and careful work on the part of the AISE Crane Wiring Committee under the chairmanship of J. E. Bodoh and C. G. Dimitt of the Carnegie-Illinois Steel Corp. This work was originally limited to crane wiring, but since the same motors are used on mill auxiliaries, it is believed that results can be applied to all types of mill motor applications, if an appropriate service factor is applied. This standard is being published as a tentative standard in order to obtain comments and criticisms from the membership before issuing this standard in its final form. Therefore, if there are any criticisms of selection, application, and presentation, it is requested that these be sent in to the AISE headquarters or be brought up at the Annual Standardization Committee Meeting which will be held in September, so that they may be taken into account before the final promulgation of this specification. It is to be noted that an alternate table is given which would replace Table II and III. This table is simpler in form than that of the Tables II and III which it would replace. The basic difference between the two is that in the alternate table, wire sizes are selected to correspond to horsepower ratings rather than to frame sizes. Therefore, the alternative table may not be as convenient to the steel plant personnel who normally think in terms of frames. On the other hand, the AISE has requested that the National Fire Protection Association revise its National Electric Code, so that it will be more in line with mill practice and the proposed specification which is outlined below. In so doing, it is advisable to delete references to specific frames so that the code will be more elastic and can more easily take into account future changes and additions to motor sizes. Thus by selecting wire sizes on a horsepower basis, complete flexibility is given.

Comments are invited as to whether the use of the alternate table will be an inconvenience or whether it is felt that it is a better way of presenting the data.

The complete detail data and research work upon which this suggested standard is based will appear in a report by C. G. Dimitt entitled "Report of AISE Crane Wiring Standardization Committee" in the July 1950 issue of the Iron and Steel Engineer . . . .

AISE STANDARD NO. 8

I. GENERAL

A. The purpose of these standards is to establish definite conductor sizes which equipment suppliers and users shall specify for wiring d-c mill type motors on crane and mill service.

B. Cranes have been classified for average duty and heavy duty services, and for indoor and outdoor applications, subject to average temperature, high temperature, and corrosive conditions.

II. SCOPE

A. Standard conductor sizes have been developed for the following types of d-c mill type motors.

1. AISE Standard, No. 1 (Sept. 1947) frame sizes 602 to 618.
2. AISE D-C Mill Motor Standards, frame sizes 2 to 18. (For existing motors only.)
3. Crocker Wheeler Type W, frame sizes AW to IW.
4. Westinghouse Type MC, frame sizes 20 to 165.
5. General Electric Type MD, frame sizes 101 to 109.

TABLE I

Classification of Crane Service

Type of crane	Service							
	I	II	A—Average duty			B—Heavy du ty		
	Indoor	Outdoor	1 Avg temp	2 High temp	3 Corrosion resistant	1 Avg temp	2 High temp	3 Corrosion resistant
1 Coke Plant and Blast Furnace Cranes:								
Drawing machine (coke pusher)		X					X	
Bucket handling		X				X		
Stock yard		X					X	
Slag handling		X						X
Scrap yard		X					X	
Cast house	X		X					
Pig machine	X			X				
Ladle house	X		X					
Skull cracker		X				X		
Sand house (bucket)	X		X					
Settling basin		X	X		X			
Car repair shop	X		X					
Ore bridge		X					X	
Coke ovens (coal bridge)		X					X	
2. Open Hearth, Electric Furnace, Bessemer Cranes:								
Charging machines	X						X	
Hot metal crane (charging)	X						X	
Ladle	X						X	
Metal mixer	X						X	
Electric furnace charging	X						X	
Stock yard		X				X		
Scrap preparation		X				X		
Scrap baler	X					X		
Scrap shear	X					X		
Hot top	X					X		
Bucket		X					X	
Slag handling		X					X	
Cinder yard		X					X	
Skull cracker		X				X		
General service	X	X	X					
3. Ingot Handling Cranes:								
Ingot handling		X				X		
Soaking pit	X						X	
Stripper	X						X	
Mold yard		X					X	
4. Rolling Mill Cranes:								
Slab yard	X					X		
Slab furnace charging	X						X	
Slab chargers overhead	X						X	
Plate and strip handling	X						X	
Billet mill	X		X			X		
Billet shipping	X					X		
Rail mill	X		X			X		
Rail loading dock	X	X	X			X		
Rail shipping	X	X				X	X	
Hot mill	X					X	X	
Cold strip mill	X					X		
Coil storage	X					X		
Roll shop	X		X					

Type of crane	Service							
	I	II	A—Average duty			B—Heavy duty		
	Indoor	Outdoor	1 Avg temp	2 High temp	3 Corrosion resistant	1 Avg temp	2 High temp	3 Corrosion resistant
Mill service	X					X		
Machine shop	X		X					
Cooling building	X					X		
Inspection and conditioning	X		X					
Pit cover	X					X		
5. Finishing Mill Cranes:								
Slab storage	X	X				X		
Charging machines	X					X		
Billet yard	X	X				X		
Furnace room	X						X	
Mill service	X					X		
Shipping	X					X		
Warehouse	X					X		
Steck	X		X					
Sorting room	X		X					
Shear	X					X		
Scale pits	X		X					
Hot bed	X			X			X	
Pickling	X					X		X
Quenching	X			X				
Tin mill	X						X	
Annealing	X						X	
Battery shop	X		X		X			
Scarfing	X					X		
6. Rod and Wire Mill Cranes:								
Billet yard	X					X		
Furnace skid charging	X		X					
Rod mill	X		X					
Rod dock		X				X		
Cleaning house	X					X		
Pot annealing	X					X		
Rod storage	X					X		
Patenting department	X		X					
Bar bending and storage	X					X		
Shipping	X					X		
7. Tube Mill Cranes:								
Hot mill	X						X	
Finishing mill	X					X		
Galvanizing	X							X
8. Miscellaneous Cranes:								
Forging manipulators	X						X	
Hydraulic forging	X						X	
Warehouse	X	X	X					
Gantry		X				X		
Repair	X		X					
Machine shop	X		X			X		
Service	X		X					
Weld shop	X		X					
Power house	X		X					
Coal lorry (boiler house)	X	X	X					
Meter room	X		X					

TABLE II

AISE Wiring Standards—AISE D-C Mill Motor

Motor frame data					Motor frame ratings						Average intermittent duty service		Heavy intermittent duty service		Continuous duty —Force ventilated service	
AISE 1949	AISE 1940	General Electric	Westing-house	Crocker Wheeler	Hp 1 hr	Amp 1 hr	Hp ½ hr	Amp ½ hr	Hp cont	Amp cont	Condr size per leg	Conduit size, in.	Condr size per leg	Conduit size, in.	Condr size per leg	Conduit size, in.
2	2	MD-402	MC-21	SW-5	5	21	6½	29	5	21	8	1¼	8	1¼	8	1¼
602	3	MD-403	MC-31	SW-7½	7½	31	10	44	7½	31	8	1¼	8	1¼	8	1¼
603	4	MD-404	MC-41	SW-10	10	40	13½	57	10	40	8	1¼	8	1¼	8	1¼
604	6	MD-406	MC-61	SW-15	15	57	19	77	15	57	8	1¼	6	1¼	6	1¼
606	8	MD-408	MC-81	SW-25	25	95	33	126	25	95	4	1½	2	2	2	2
608	10	MD-410	MC-101	SW-35	35	132	45	175	35	132	2	2	1	2	1/0	2
610	12	MD-412	MC-121	SW-50	50	185	65	245	50	185	1/0	2	2/0	2½	3/0	2½
612	14	MD-414	MC-141	SW-75	75	272	100	368	75	272	3/0	2½	4/0	2½	300	3
614	16	MD-416	MC-161	SW-100	100	360	135	500	100	360	250	3	300	3	500	3(2)*
															2-3/0	2½(2)
616	18	MD-418	MC-181	SW-150	150	540	200	740	150	540	400	3(2)*	500	3(2)*		
											2-3/0	2½(2)	2-250	3(2)	2-300	3(2)
618	.....	MD-420	.....	.....	200	730	265	960	200	730	2-250	3(2)	2-300	3(2)	2-500	3(4)

*Numbers in parentheses indicate number of conductors in conduit.

TABLE III

AISE Wiring Standards—Miscellaneous D-C Motors

Motor data								Average intermittent duty service		Heavy intermittent duty service		Continuous duty —Force ventilated service	
Frame size	Mfr	Hp 1 hr	Amp 1 hr	Hp ½ hr	Amp ½ hr	Hp cont	Amp cont	Condr size per leg	Conduit size, in.	Condr size per leg	Conduit size, in.	Condr size per leg	Conduit size, in.
101	G-E	4	17	5	23	4	17	8	1¼	8	1¼	8	1¼
20	West	6	25	7½	34	6	25	8	1¼	8	1¼	8	1¼
AW	C-W	8	37	10	50	8	37	8	1¼	8	1¼	8	1¼
102	G-E	9	33	12	50	9	33	8	1¼	8	1¼	8	1¼
30	West	12	47	15	62	12	47	8	1¼	6	1¼	6	1¼
103	G-E	13	50	17	70	13	50	8	1¼	6	1¼	6	1¼
BW	C-W	16	56	20	86	16	56	8	1¼	6	1¼	6	1¼
40	West	20	76	28	116	20	76	6	1¼	4	1½	4	1½
104	G-E	20	77	30	124	20	77	6	1¼	2	2	4	1½
CW	C-W	25	88	30	112	25	88	6	1¼	4	1½	2	2
104½	G-E	30	112	45	175	30	112	3	1½	1	2	2	2
50	West	30	114	40	157	30	114	3	1½	2	2	2	2
DW	C-W	36	138	45	180	36	138	2	2	1	2	1/0	2
105	G-E	40	154	50	200	40	154	1	2	1/0	2	1/0	2½
EW	C-W	47	175	60	245	47	175	1/0	2	2/0	2½	2/0	2½
60	West	50	172	65	250	50	172	1/0	2	2/0	2½	2/0	2½
FW	C-W	66	240	85	320	66	240	3/0	2½	3/0	2½	250	3
70	West	70	255	90	346	70	255	3/0	2½	4/0	2½	250	3
106	G-E	70	264	85	324	70	264	3/0	2½	4/0	2½	300	3
107	G-E	85	316	110	432	85	316	4/0	2½	250	3	350	3(2)*
												2-2/0	2½(2)
80	West	85	320	110	410	85	320	4/0	2½	250	3	350	3
												2-2/0	2½(2)
GW	C-W	90	310	110	400	90	310	4/0	2½	250	3	350	3(2)
90	West	100	360	140	520	100	360	250	3	300	3	500	3(2)
												2-3/0	2½(2)
108	G-E	100	365	140	565	100	365	250	3	300	3	500	3
												2-3/0	2½(2)
HW	C-W	120	440	160	590	120	440	300	3	350	3(2)*	2-4/0	2½(2)
100	West	150	540	200	730	150	540	400	3(2)*	500	3(2)	2-300	3(2)
								2-3/0	2½(2)	2-250	3(2)		
IW	C-W	175	620	225	800	175	620	500	3(2)	2-250	3(2)	2-350	3(4)
								2-4/0	2½(2)				
109	G-E	175	640	225	840	175	640	500	3(2)	2-250	3(2)	2-350	3(2)
103	West	180	660	250	900	180	660	2-250	3(2)	2-300	3(2)	2-400	3(4)
165	West	275	970	325	1160	275	970	2-350	3(2)	2-400	3(2)	3-400	3(4)

*Numbers in parentheses indicate number of conductors in conduit.

ALTERNATE TABLE FOR TABLES II AND III

Wire Sizes for D-c Mill Type Motors

Motor frame data						Heavy duty intermittent service		Average duty intermittent service		Heavy duty continuous force ventilated service	
Hp ½ hour	Amp ½ hour	Hp 1 hour	Amp 1 hour	Hp continuous force ventilated	Amp continuous force ventilated	Conductor size per leg	Conduit number and size, in.	Conductor size per leg	Conduit number and size, in.	Conductor size per leg	Conduit number and size, in.
5-13½	23-57	4-10	17-40	4-10	17-40	8	1-1¼	8	1-1¼	8	1-1¼
15-20	62-86	12-16	47-57	12-16	47-57	6	1-1¼	8	1-1¼	6	1-1¼
28-40	116-157	20-30	76-114	20-30	76-114	2	1-2	4	1-1½	2	1-2
45	175-180	30-36	112-138	30-35	112-138	1	1-2	2	1-2	1	1-2
50	200	40	154	40	154	1/0	1-2	1	1-2	1/0	1-2
60-65	245-250	47-50	175-185	47-50	175-185	2/0	1-2½	1/0	1-2	3/0	1-2½
85-100	320-368	66-75	240-272	66-75	240-272	4/0	1-2½	3/0	1-2½	300	1-3
110	400-432	85-90	310-320	85-90	310-320	250	1-3	4/0	1-2½	350 or 2-2/0	2-3 2-2½
135-140	500-565	100	360-365	100	365	300	1-3	250	1-3	500 or 2-3/0	2-3 2-2½
160	590	120	440	120	440	350	2-3	300	1-3	2-4/0	2-2½
200-225	730-840	150-175	540-640	150-175	540-640	2-250	2-3	500	2-3	2-350	4-3
250-265	900-960	180-200	660-730	180-200	660-730	2-300	4-3	2-250	2-3	2-500	4-3
325	1160	275	970	275	970	2-400	4-3	2-350	4-3	3-400	4-3

III. CRANE CLASSIFICATION

A. To simplify the classification of cranes, Table I lists the majority of crane applications encountered in steel plants. This table is based on Table 43-III included in the AISE Crane Specifications AISE Standard No. 6. The tabulation of types of cranes follows Table 43-III very closely.

B. Two general types of crane service are shown in Table I, average duty and heavy duty. These selections are based on experience, on the "average number of hours operation in one year," the "per cent time on in operational hour," and the "number of moves per hour." Referring to Table 43-III, a crane operated over 4300 hours a year (50 per cent of the overall average hours), having a motion with 40 per cent or more time on in operational hours, or having more than 35 moves per hour may generally be classified as subject to heavy duty service. A crane operated less than 4300 hours a year, having all motions requiring less than 40 per cent time on in operational hour, and having less than 35 moves per hour may

TABLE IV

Wire Data

Wire size	RH 75C Wire—Amp			AVA 110C Wire—Amp			RH 75C Wire	
AWG and MCM	60 min rating	30 min rating	Continuous rating	60 min rating	30 min rating	Continuous rating	Insulation thickness, in.	Jacket thickness, in.
8	55	60	45	73	80	60	4/64	1/64
6	76	86	65	93	105	80	4/64	2/64
4	100	117	85	126	147	107	4/64	2/64
2	137	160	115	163	190	137	4/64	2/64
1	143	175	.....	177	215	161	5/64	3/64
1/0	190	233	150	239	294	190	5/64	3/64
2/0	222	267	175	275	331	217	5/64	3/64
3/0	280	341	200	339	413	243	5/64	3/64
4/0	295	369	230	352	440	275	5/64	3/64
250	364	420	255	447	516	315	6/64	4/64
300	455	582	285	554	707	347	6/64	4/64
350	486	646	310	616	809	392	6/64	4/64
400	538	688	335	666	856	418	6/64	4/64
500	660	847	380	815	1004	468	6/64	4/64

be generally considered as subject to average duty service. If the maximum crane temperature during operation is over 55 C (131 F), the service may be classified as high temperature. If the maximum crane temperature is under 55 C (131 F), the service may be classified as average temperature. Classifications of indoor, outdoor, and corrosion resistant are included to cover distinctions in equipment or protective features which may be necessary for cranes in such service.

C. Due to the differences in plant layouts, given types of cranes may be indoor and outdoor, average and high temperature, or average and heavy duty. A service classification may be fully covered by a symbol such as IB2, for open hearth charging machines, meaning that the classification is indoor, heavy duty, and subject to high temperature. These symbols are used for classification reference in the conductor cable standards, and are keyed to the headings in Table I.

IV. CONDUCTOR SIZES

A. Standard conductor sizes or conductor sizes per leg, conduit size and number are listed in Tables II and III. These tables also give motor data and ratings. Wire size for average intermittent duty service has been selected so that it can carry one hour motor rated current for 60 minutes without raising the total temperature of RH wire over 75 C and AVA wire over 110 C. Wire size for heavy duty intermittent service has been selected so that it can carry 30-minute motor rated current for 30 minutes without raising the total temperature of RH wire over 75 C and AVA wire over 110 C. Wire size for continuous duty, force ventilated service has been selected so that it can carry the 1-hour rating of the motor continuously without raising the total temperature of RH wire over 75 C and AVA wire over 110 C. For crane motors having intermittent service, wires will be selected on an average duty and heavy duty basis as determined by the data given in Table I. Application data for heavy duty service applies to both self-ventilated and force ventilated frames.

B. The assigned current ratings which have been established for the conductor sizes selected in RH (rubber) and AVA insulations are given in Table IV.

C. For compound or shunt wound motor shunt field circuits, two number 8 conductors in 1-in. conduit shall be used.

V. CONDUCTOR INSULATION

A. For cranes and mill auxiliary drives, if the maximum motor ambient temperature during operation is under 55 C (131 F), RH cable with moisture resistant 75 C insulation with neoprene covering and standard stranding will be used. For cranes, these normally are the items which are listed in the average temperature and corrosion resistant columns of Table I. If the maximum motor ambient temperature during operation is over 55 C (131 F), AVA cable having asbestos varnished cambric asbestos 110 C insulation with moisture resistant impregnation and standard stranding will be used. For cranes, these are the items listed under the high temperature columns of Table I.

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ELECTRIC WELD TUBE MILL

Goes into Production

AT NATIONAL TUBE CO.'S McKEESPORT WORKS

▲ A new tube mill with an annual capacity of 100,000 tons of electric welded steel pipe, in sizes ranging from 26 to 36 in., started production in April in McKeesport, Pa., at the National Works of U. S. Steel's National Tube Co. Stock for the mill consists of plates from ¼ to ½ in. in thickness. These plates, whose steel composition runs 0.20 to 0.30 carbon and 0.85 to 1.25 manganese, weigh close to two tons each. Standard length is 40½ ft while the widths will vary, according to specifications, from 78½ to 110 in.

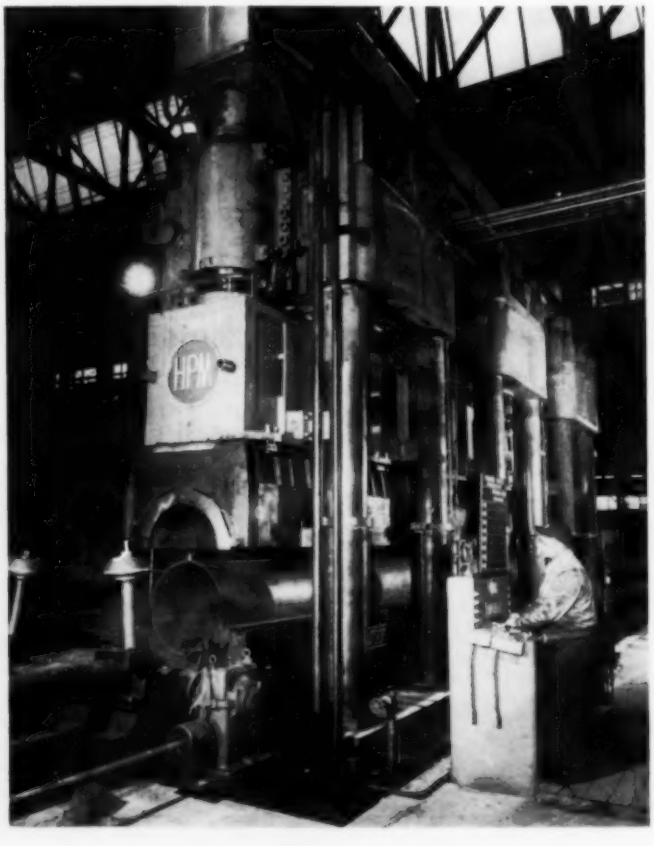
The conversion of plates to tubes is accomplished in sixteen big new machines which are the major units of the mill. Ample use of roller conveyors for moving the heavy material from unit to unit makes possible an assembly-line precision of operation. Plate stock is first end-sheared, then side-planed and beveled. After edge-rolling, the first forming operation, the plate is formed into a "U" by a heavy press. Another press further forms the stock into a tube, after which it is welded outside and inside. It then undergoes an inspection before being expanded in a huge hydraulic machine that increases the diameter by actually stretching the steel under water pressures up to 3000 psi. On the initial order, tubes were formed to 29½ in. inside diameter and expanded to 30 in. under pressure of 1700 psi. From the expander, tubes are beveled and end-faced. They then receive a final inspection by both company and customer.

The plates, which are rolled at the Homestead Works of Carnegie-Illinois, are unloaded in the west end of the new mill into three stock piles. Material is started through the plant from a transfer car of 10 tons capacity. A 10-ton crane services this area.

When the transfer car has been loaded, it is rolled into line with a conveyor table. Electric magnets mounted on a remote-control trolley feed the plates onto the conveyor leading to two end-shears. These conventional down-cut mechanical shears are mounted together in line. The sheared plate moves onto a run-out table and is then conveyed by drag chain to the planer feed table.

Figure 1 — A 2000-ton hydraulic press is used to make a "U"-turn in the flat steel plate for the new electric weld pipe mill of National Tube Co.'s McKeesport plant.

Figure 2 — An 18,000-ton hydraulic press rounds out the pipe prior to welding.



Here a square-up mechanism lines the plate for precision entry into the edge-planers.

Each of these machines, set back-to-back, consists of a clamp-down bed and a moving platform, on each of which 11 cutters are mounted. These cutters are offset for increasingly deeper cuts and beveling. Plates are discharged from the planers by a pinch-roll drive. Clamps on the movable platforms drag the next plate into position.

The planed and beveled plate is then run out to another square-up mechanism, from which it enters a plate edge-forming machine. This consists of three adjustable rolls, which give a slight curve to the plate edges. From the edge-rolls the plate is fed into the "U"-ing press by table rolls and a mechanical pusher. The "U"-ing press is 41 ft long and is capable of exerting loads up to 2000 tons. Here the plate is pressed into a deep "U" form.

A run-out table then conveys the formed plate to the "O"-ing press. Here again a mechanical pusher feeds the plate into the machine. The "O"-ing press, also 41 feet in length, is capable of pressures up to 18,000 tons and forms the plate into a tube known as a "can."

The formed can is pushed out by the next "U" plate. Pinch rolls feed it onto a conveyor. From the conveyor it is kicked to a gravity transfer which is adjustable by compressed air cylinders to the rolling momentum of any diameter of can.

By a series of conveyors and skids, the can is then dispatched to either of two outside welding machines. These are submerged twin-arc a-c fusion welders. Both are equipped with gas preheaters. Flux is fed from an overhead bin and after the weld, the unburned flux is picked up by vacuum and returned to the overhead bin for re-use. A rotating disc shears off the burned flux which then is also removed by suction into a disposal hopper. The can next moves by conveyor table to the manual squirt welders where, to assure a perfect weld and penetration on both ends of each can, approximately 6 in. of the seam are welded.

From this area the cans are rolled to two idler conveyors from which they are fed at the operator's discretion to either of two inside welders. Here the can is placed weld down on a movable carriage. The inside welders, mounted on fixed arms, consist of twin arcs with d-c on the lead and a-c on the trailing arc which, like the outside welders, are preceded by gas preheaters. A hopper on the end of the weld arm carries sufficient quantities of flux for each weld. The inside weld is the final operation converting a can into a pipe section. Excess unburned flux is removed by suction.

The pipe is then conveyed automatically to a flux remover, where the burned flux, knocked off by an automatic hammer operating on the outside of the tube, is removed by a suction cleaner. From here the pipe is again automatically returned by conveyors to one of three tables for its first inspection.

The can is thoroughly examined inside and out and any necessary minor repairs to the welds are made. Here also minor finishing operations are performed, such as chipping and grinding inside welds to customer specifications for easier field assembly.

The can then moves to the hydraulic expander. The tube is lifted into the machine and a tapered ram is inserted in the end of the can. The ends are mechan-

Figure 3 — The pipe is welded both inside and out with a submerged twin arc welding machine which is shown welding a 30-in. pipe.

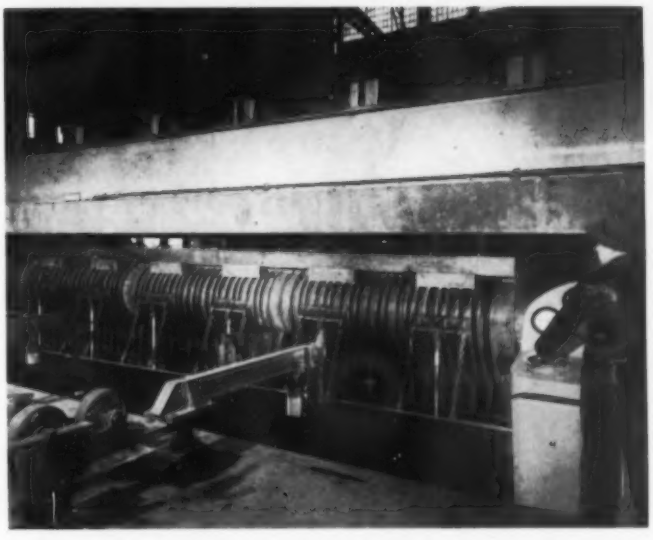
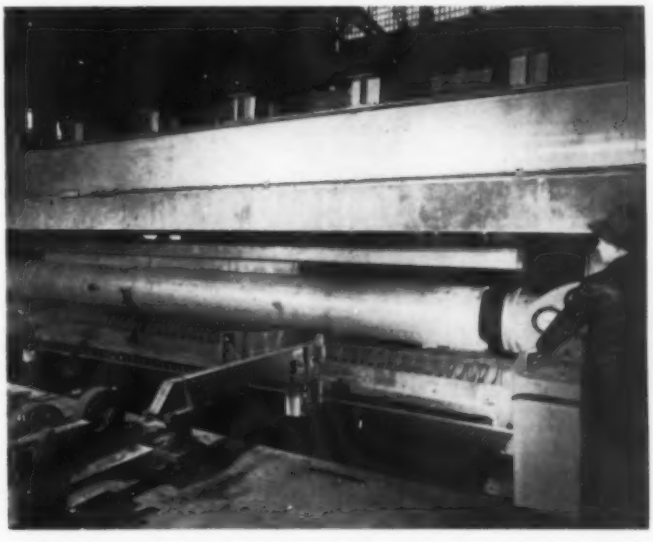


Figure 4 — The pipe is expanded almost ½ in. in diameter using a hydraulic expander machine. The pipe is surrounded by curved dies which control the amount of expansion. The operation strengthens the steel and at the same time the internal water pressure tests the pipe.

Figure 5 — Pipe is shown in the hydraulic expander in the open position just after it has been enlarged.



ically belled by pressure insertion of the tapered ram and plug. A rubber gasket seal on the ram insures a water-tight connection. A four section die, machined to the specified finished OD, is placed around the pipe, which is then filled with water. The expander machine is capable of exerting pressures up to 3000 psi.

The thickness of the tube walls determines the pressure applied to expand the pipe up to the specified outside diameter. As the pipe enlarges in diameter it is reduced in length. As it reduces in length, the plunger automatically advances to maintain a water-tight seal. Water pressure is then dropped below the yield point of the steel. Two end dies are opened and air hammers are struck against the pipe for testing. If no leaks appear, the other two dies are opened, pressure is again dropped and the entire seam is inspected visually for leaks.

Three centrifugal pumps supply water to the expander from a 25,000 gallon reservoir. Pressure is applied by means of two accumulator systems, one of 3000 pounds and one of 1200 pounds capacity. Water from the expander is drained into a sump. A lip overflow from the sump into the reservoir assures scale-free water for the expander. A scale bucket in the sump makes easy the recovery of scale and keeps the sump clean.

The expanded tube now moves by conveyors to a double end-facing machine. Each of the two facers is equipped with three cutters which bevel and face the ends of the pipe. It then moves to two inspection areas, in the first of which it receives a company inspection and in the second a customer inspection. These areas are provided with conveyors so that any can not passing inspection can be returned directly to the repair areas. Another 10-ton crane services this portion of the mill. After passing inspection the tube is ready for shipment.

Welded tubes produced in this plant are shipped by gondola and loaded in four tiers of three each. The freight car loads are braced on either side with five timbers and steel strapping is passed from side to side to hold the pipe in place. The top of the load is bound down with steel cable.

To provide power for the new mill, a transformer station was built. There are three unit substations in the mill area, two of 1000 kva and one of 1500 kva.

Compressed air for the new mill is taken from the plant system, but in order to assure sufficient pressure, a new compressor was installed to feed into the plant system.

AISE REVISES BY-LAW

.... The Board of Directors of the Association of Iron and Steel Engineers approved a number of revisions to BY-LAW I which outlines the government of the district sections. The revised by-law is given below ....

DISTRICT SECTIONS

Section 1. Officers — Each district section shall have a Chairman and a Vice Chairman. The officers shall be active members and in good standing at the time of their election.

It shall be the duty of the Chairman to take charge of the district section, to preside at all meetings of the district section and of the District Executive Committee. He shall have supervision and management of the district section and its property subject to approval of the Board of Directors. The district section Chairman shall be Chairman of the District Section Executive Committee.

The duties of the Vice Chairman shall be to assist the Chairman in the discharge of his duties, to preside at meetings in the absence of the chairman, and discharge his duties in case of vacancy in the office.

Each district section shall have a Secretary appointed by the District Section Chairman, subject to the approval of the Board of Directors. He shall serve for one year or until his successor has been appointed and approved. The District Section Secretary shall be under the direction of the Chairman of the section, and the President and Managing Director of the Association.

The duties of the District Section Secretary shall be to attend to all correspondence and business in connection with operating the district section, subject to the approval of the District Section Chairman.

Section 2. Election of Officers — The District Section Chairman shall name three or more past-chairmen of the section as a Nominating Committee, who will report their selection of candidates for Chairman, Vice Chairman and Executive Committee. Other nominations may be made from the floor or by such other means as the section may set up. Election shall be by vote of the active members, and the candidates receiving the majority of votes shall be declared elected. The Chairman's, Vice Chairman's and Executive Committee's term of office shall be from July 1 to July 1.

Section 3 Executive Committee — The District Executive Committee shall be composed of the Chairman, the Vice Chairman, the junior Past-Chairman, and three or more active members elected as set forth in Section 2.

The duties of the Executive Committee shall be to develop further activities for the district section and in general to increase the effectiveness and usefulness of the district section to its members, to the Association, and to the iron and steel industry.

Section 4. Advisory Committee — There shall be a District Section Advisory Committee composed of all past-chairmen of the district section.

Section 5. Papers Committee — There shall be a District Section Papers Committee composed of members appointed by the District Section Chairman.

The duties of the District Section Papers Committee are to recommend authors, papers, movies, etc., for the meetings of the section.

Section 6. Meetings and Attendance Committee — There shall be a District Section Meetings and Attendance Committee composed of members appointed by the District Section Chairman.

The duties of the District Section Meetings and Attendance Committee shall be to provide a place for the meetings of the section, to arrange for dinners and entertainment incident to the meetings, and to stimulate interest in the meetings.

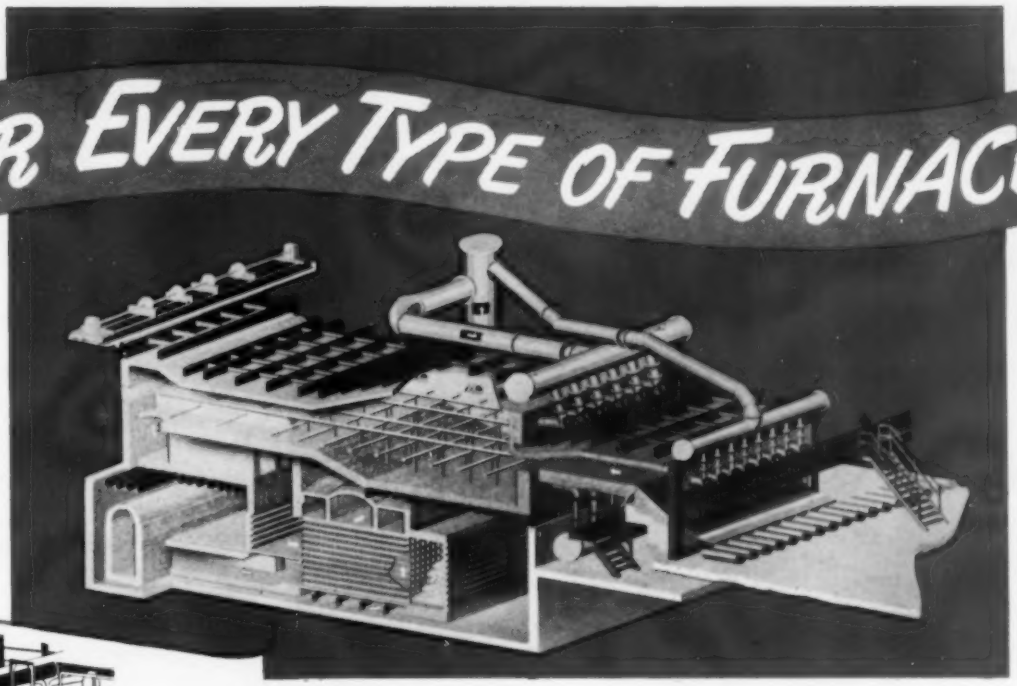
Section 7. Reception Committee — There shall be a District Section Reception Committee composed of members appointed by the Section Chairman.

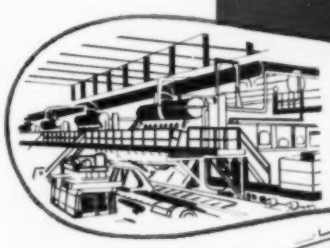
The duties of the District Section Reception Committee shall be to receive new members and guests, and to promote good fellowship between the district section members.

Section 8. Membership Committee — There shall be a District Section Membership Committee composed of members appointed by the District Section Chairman.

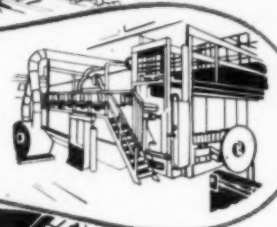
The duties of the District Section Membership Committee shall be to secure new members for the section and to work with the Association's National Membership Committee.

FOR EVERY TYPE OF FURNACE

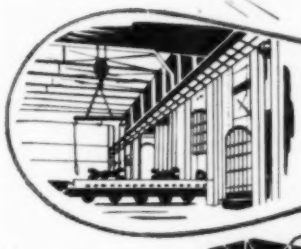




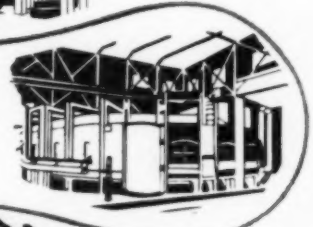
SLAB, BLOOM, BILLET, BAR HEATING FURNACES



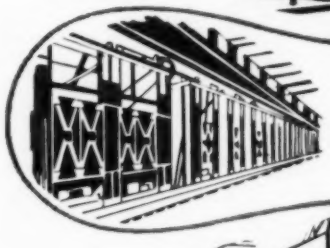
CONTINUOUS PIPE ANNEALING FURNACES



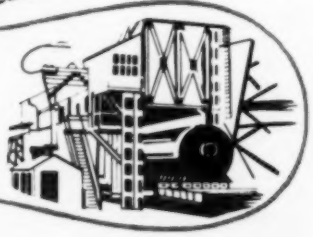
CAR BOTTOM TYPE HEAT TREATING FURNACES



ROTARY HEARTH, BLOOM AND BILLET HEATING FURNACES



BOX ANNEALING FURNACES



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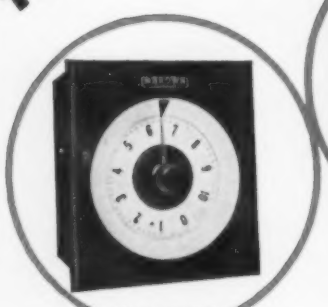
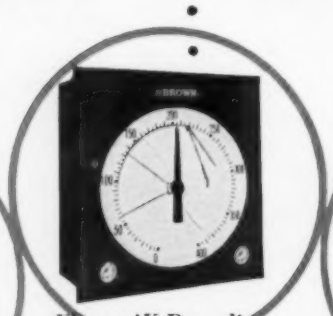


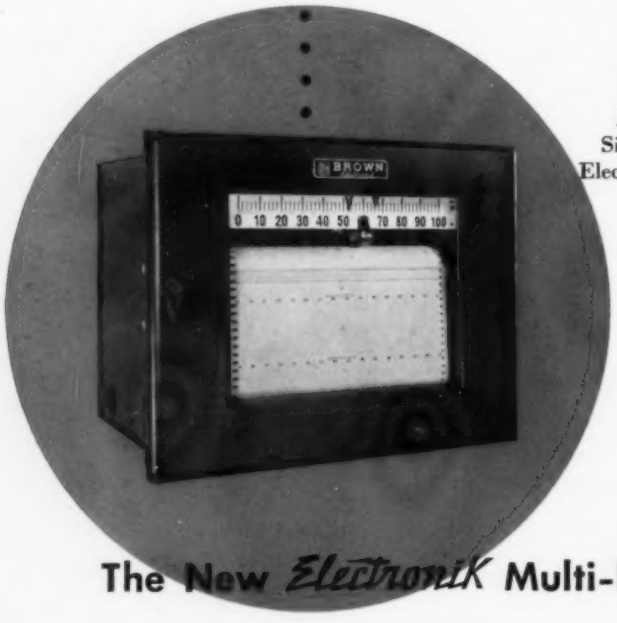
ElectroniK Indicating Controller



ElectroniK Recording Pneumatic Controller

ElectroniK Recording Electric Controller

ElectroniK Single Record Electric Controller



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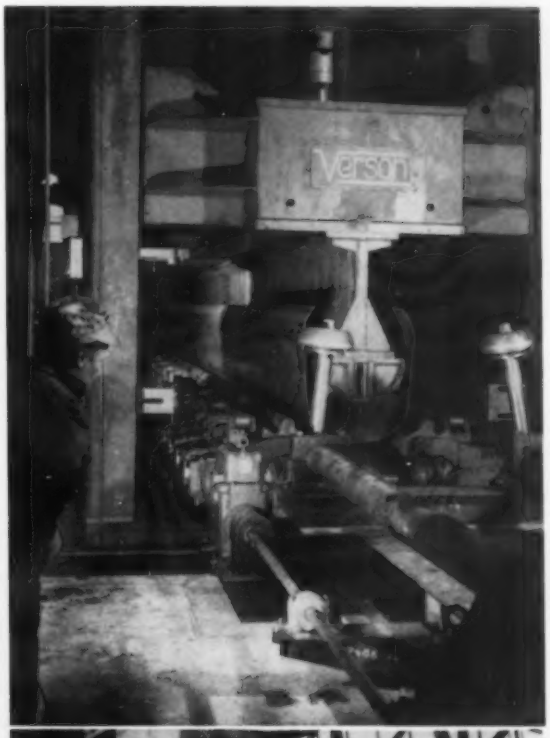

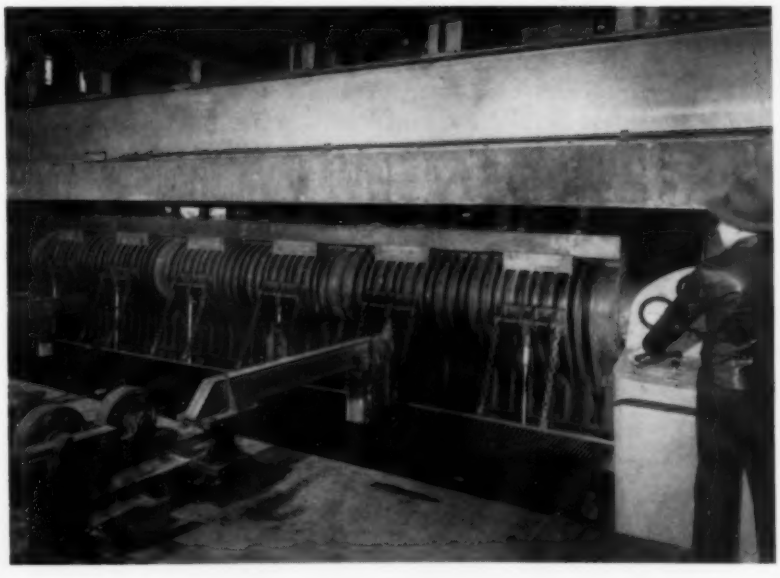

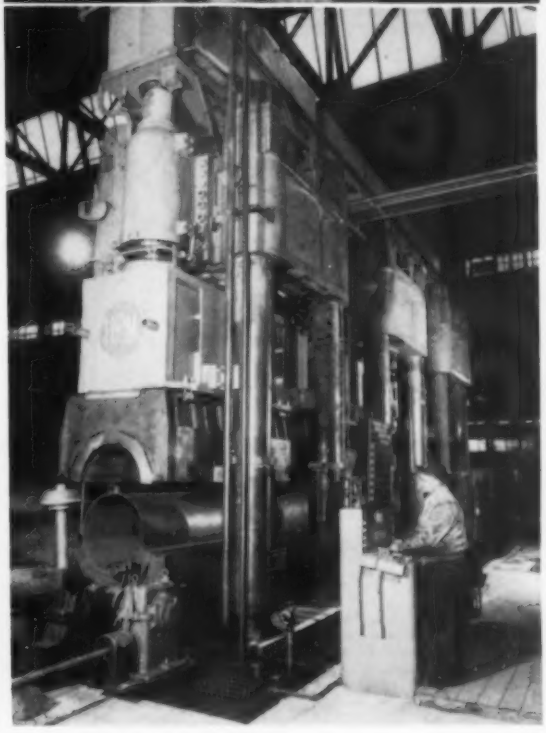

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Date-line Diary...

May 1

▲ At the general meeting of the Tata Iron & Steel Co., Ltd., Mr. J. R. D. Tata stated that the company is in need of one open hearth plant, a battery of coke ovens and new equipment for their blooming mill, plate mill, power plant and soaking pits in the next five years. This is in addition to routine requirements.

▲ Irving S. Olds stated that the United States Steel Corp. will definitely build an integrated steel mill at Morrisville, Pa.

▲ Ben Moreell stated that Jones & Laughlin Steel Corp.'s modernization program will cost $273,000,000 by 1952.

▲ The operating rate of the steel industry is scheduled at 100.2 per cent of capacity for the week beginning May 10. This is equivalent to 1,910,100 tons compared with 1,912,000 tons one week ago.

May 2

▲ The Department of Commerce reported that imports of manganese ore in 1949 were up 23 per cent in spite of an 81 per cent reduction in Russian shipments.

▲ The Commerce Department reported that new construction put in place in April was $1,700,000,000, a new high for the month.

▲ A flash fire at the Weirton Steel Co.'s new tin mill put the plant temporarily out of production. Fire started in the oil hydraulic system.

▲ The price of zinc went up ¼¢ to 11¼¢ a lb in East St. Louis.

May 3

▲ The Treasury Department reported that the government spent $2,588,000,000 more than its income during the first ten months of the fiscal year and expects a deficit of $5,400,000,000 by the end of the fiscal year.

▲ The House Public Lands Committee approved a $330,000,000 subsidy for financial aid to mining companies in operating existing mines and in exploring for new mineral deposits.

May 4

▲ No. 1 heavy melting scrap in Pittsburgh is selling for $35 and $36 a ton.

▲ Price of lead went up ¼¢ to 11¼¢ a lb in New York. Zinc price went up ¼¢ to 11½¢ a lb in East St. Louis.

May 5

▲ American Railway Car Institute reported that freight car deliveries in April were 971. Orders in April were 3308 and the backlog at the end of the month was 32,857 compared with 30,539 on April 1st.

May 6

▲ The British Iron and Steel Federation stated that the cost of making steel in Great Britain will go up $16,800,000 a year when rail freight rates are increased 16 per cent on May 15.

May 7

▲ The Allegheny Ludlum Steel Corp. has approved a $23,600,000 plant improvement program which will be undertaken during the next three years. Included in the program is a new hot strip mill and additional cold rolling facilities as well as a research laboratory.

▲ The Steel Co. of Canada settled with the CIO giving the union a 40 hour week and a 13¢ wage increase of which 8¢ is given effective April 1, 1950 and the additional 5¢ becomes effective April 1, 1951.

May 8

▲ The operating rate of the steel industry for the week beginning May 8 will be 100.1 per cent of capacity. This is equivalent to 1,908,000 tons compared with 1,910,100 tons one week ago.

▲ The ECA reported that industrial products produced in Europe are now up to 120 per cent of the prewar average.

▲ No. 1 heavy melting scrap in Pittsburgh sold at $36.00 a ton today.

May 9

▲ The price of zinc went up ½¢ to 12¢ a lb in East St. Louis.

▲ Class 1 Railroads reported that net income in first 3 months of 1950 was $53,000,000 off $9,000,000 from the same period in 1949.

May 10

▲ United States Steel Corp. announced that four of its subsidiaries concluded agreements with the CIO on elimination of plant salary rate inequities. Salary scale starts at $83.00 for a bi-weekly period.

▲ President's council of Economic Advisers reported that business trends continued upward in April and industrial production for the first three months of 1950 ran at an annual rate of $262,000,000,000 compared with $258,000,000,000 in 1949.

▲ Price of lead went up ¼¢ to 11½¢ a lb in New York.

▲ The ECA approved the installation of a new rail and structural steel mill at Alpin, Montan, Austria. Overall cost is $6,100,000 of which ECA provides a third.

▲ Four major railroads went on strike today as the firemen struck for a third man on multiple-unit diesel locomotives. Railroads affected were Pennsylvania Railroad, New York Central, Southern and Santa Fe.

May 11

▲ Lead price went up a ½¢ a lb to 12¢ in New York.

▲ Steel production in April totaled 8,196,050 tons, a new record for the month according to the AISI.

May 12

▲ The French government proposed that France and Germany pool their coal and iron resources. This pool would control an annual production of 175,000,000 tons of coal and 20,000,000 tons of steel.

May 14

▲ The Bureau of Employment Security states that employment this summer will probably be over 60,000,000.

▲ The Securities and Exchange Commission and Federal Trade Commission reported that net income after taxes of United States manufacturing companies was $9,000,000,000 in 1949 or 22 per cent below 1948.

▲ Interstate Commerce Commission reported that passenger service gave United States Railroads a deficit of $649,300,000, 16 per cent above the 1948 record. Freight service gave the railroads a net operating income of $1,335,100,000.

▲ Sir John Craig, a British steel maker stated that

there will be a capacity of steel in Europe within the next three years of over 8,000,000 tons a year more than can be used.

May 15

▲ The operating rate for the steel industry beginning the week of May 15th is scheduled at 101.3 per cent of capacity. This is equivalent to 1,931,000 tons of steel, a new record, compared with 1,908,200 tons one week ago.

▲ Aluminum Association reported that production of primary aluminum in the first quarter was 322,425,008 lb. Shipments of aluminum sheet, plate and strip in the first quarter were 259,772,157 lb.

▲ American Iron and Steel Institute reported that total shipments of steel to the automobile industry were 1,208,000 net tons in March, a new record.

May 16

▲ The Railway firemen ended their strike against four major railroads.

▲ The House Ways and Means Committee approved a 10 per cent withholding tax on corporate dividends.

May 17

▲ No. 1 heavy melting scrap rose $1.00 a ton to $37.00 in Pittsburgh.

▲ The Lake Carriers Association reported that ice conditions have hampered navigation of ore carriers in the upper lakes enough so that shipments of ore are about 8,000,000 tons behind last year.

May 18

▲ Copper prices advanced 1¢ a lb to 20½¢.

May 19

▲ The Aluminum Co. advanced the price of 99 per cent aluminum ½¢ to 16½¢ a lb for aluminum pig and to 17½¢ a lb for aluminum ingots.

▲ The Federal Trade Commission asked Congress to allot it $250,000 for study in the petroleum industry.

May 20

▲ The Jones and Laughlin Steel Corp. broke ground on its six furnace open hearth plant at its Pittsburgh Southside Plant, which is estimated to cost $42,000,000. Swindell Dressler Corp. is the general contractor.

May 21

▲ The Continental Steel Co. authorized construction of a new continuous rod mill at an estimated cost of $5,000,000.

May 22

▲ The operating rate of the steel industry for the week beginning May 22 is estimated at 101.8 per cent of capacity. This is equivalent to 1,940,600 compared with 1,931,000 one week ago.

▲ Spokesman for the Bituminous Coal Operators and the United Mine Workers told the Senate Labor subcommittee that Federal aid was needed for the soft and hard coal industries to counteract the effects of importation of foreign oil.

May 23

▲ The British government dropped its steel allocation plan which has been in effect for the past ten years with the exception for sheet and tin plate.

▲ The United Auto Workers and General Motors Co. agreed to a new five year contract thus eliminating the possibility of a strike. Future wage increases are provided for the next five years and the settlement is tied in with the cost of living wage formula.

May 24

▲ The Reynolds Metal Co. raised the price of aluminum ½¢ a lb sharing a similar increase with the Aluminum Co. of America.

▲ According to Business Week building costs are going up again and houses which were $9800 in 1948 are now at $11,500.

▲ Price of zinc advanced ½¢ a lb to 12½¢ a lb in East St. Louis.

▲ According to the American Iron and Steel Institute, major steel producers made arrangements to import several hundred thousand tons of steel scrap from Germany.

May 25

▲ The Algonquin Gas Transmission Co. completed its plans to bring natural gas to New England.

▲ American Institute of Steel Construction reports that April bookings of fabricated structural steel were 150,542 tons compared with 189,420 tons in March. Shipments in April were 155,072 tons compared with 156,781 tons in March. The backlog for the next four months is estimated at 540,213 tons.

May 26

▲ The National Safety Council reported that the frequency of accidents in the steel industry was 4.96 injuries per 1,000,000 manhours for 1949, which is down 15 per cent from 1948 and well above the overall industry average of 10.14. The severity of accidents in the steel industry in 1949 was 1.49 days lost per 1000 hours which is 10 per cent below 1948 and slightly greater than the overall industry average of 1.02.

▲ The Kaiser Steel Corp. revealed that it had concluded a contract with Trunkline Gas Supply Co. to produce $35,000,000 of steel line pipe for a 1300 mile Texas-Illinois natural gas line.

▲ The Bureau of Labor Statistics reported that production workers earnings hit a new high of $56.89 in April or $3.00 higher than one year ago.

▲ George Love, president of the Pittsburgh Consolidation Coal Co. announced that a permanent program is being set up to negotiate future contracts with the United Mine Workers. Harry M. Moses, president of the H. C. Frick Coke Co. has been asked to head the new group.

May 27

▲ Gasoline rationing was ended in Great Britain.

▲ According to Ward's automotive reports, automobile and truck output in the United States and Canada this week was a record 183,670 units.

May 28

▲ Walter Reuther, president of CIO Auto Workers stated that the General Motors settlement will be the 1950 pattern for the union negotiations with other firms in the auto industry.

▲ Carnegie-Illinois Steel Corp. announced that it will build two new coke oven batteries of 87 ovens each at the Clairton Works. Contract was awarded the Koppers Co.

May 29

▲ American Iron and Steel Institute reports that steel production for the week beginning May 29 was 101.5 per cent of capacity. This is equivalent to 1,934,900 tons compared with 1,940,600 tons one week ago.

May 30

▲ Price of zinc advanced ½¢ a lb to 13¢ a lb in East St. Louis.

May 31

▲ General Electric announced it will spend $50,000,000 to improve and increase its production facilities.

▲ Republic Steel Corp. announced that it will expand its steel making capacity in the Cleveland District about 10 per cent.

▲ Nickel prices were advanced 8¢ a lb by the International Nickel Co. to 48¢ a lb.

▲ No. 1 steel scrap price rose $3.00 to $42.00 a ton for the highest level in eighteen months.

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The husky load of scrap in the photograph weighs practically the same as the first load lifted eight hours earlier. Why?

Ohio Magnets lift efficiently—*uniformly*—over extended periods of operation because they operate *cooler*. Copper coils are heavier-duty, carefully sealed with plenty of non-cracking asphaltum.

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OHIO PROTECTO-WELD MAGNET is welded *on top,* where weld cannot be dented in. Sizes include 39, 46, 55 and 65-inch diameters. Ohio also builds magnet control equipment.

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Ohio MAGNETS

A-2027

Industry News...

REPUBLIC STEEL CORP. TO INSTALL NEW TURBO BLOWER AT CLEVELAND PLANT

▲Installation of a new turbo blower at the Cleveland, Ohio, district plant of Republic Steel Corp., has been announced.

Designed to deliver 125,000 cfm with a pressure of 40 lb psi, the blower will enable the plant ultimately to convert its No. 1 blast furnace to "pressure blowing." Because it increases production of iron and cuts down coke consumption, "pressure blowing" is regarded as one of the outstanding technological advancements in blast furnace operation of recent years.

Republic's Warren, Ohio, plant is the only other blast furnace plant in the world operating a turbo blower with as large a capacity. Five of the company's 21 blast furnaces have already been converted to "pressure blowing." It has been estimated that the application of the "pressure blowing" technique to these five furnaces results in an increase in iron production almost the equivalent of an additional furnace.

Completion of the new turbo blower in Cleveland will permit the eventual retirement of seven vertical steam blowing engines.

ORE BRIDGE TO BE BUILT AT HOMESTEAD PLANT

▲ A new ore bridge that can handle well over a million tons of iron ore annually will be built at Homestead district works of Carnegie-Illinois Steel Corp., it was announced recently by H. G. McIlvried, general superintendent.

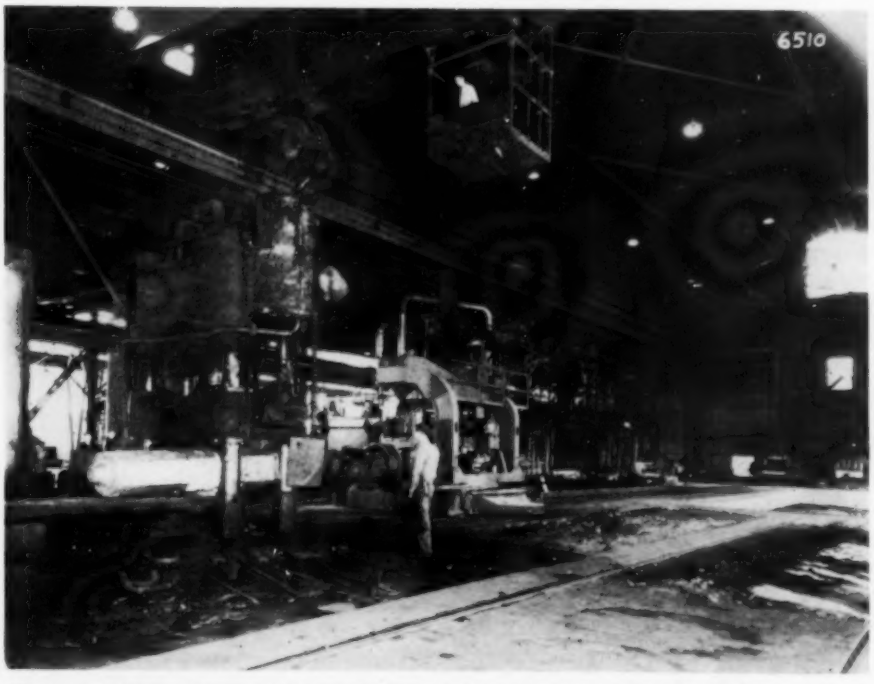
The big bridge will be used to stock iron ore and transfer it to blast furnaces at the company's Carrie furnaces, located across the Monongahela river from the main plant. These stacks supply the molten iron used in the open hearth furnaces at Homestead.

The project is now in the engineering stage, with construction scheduled to start soon. The new bridge is expected to be placed in use before the end of the year. It will replace two smaller ore bridges that have been in continuous use since 1906.

The new facility will span 186 ft across the ore stockyard that serves two of the blast furnaces, and will travel the entire length of the stockyard, a distance of 506 ft. Thirty-two wheels, eight to each corner, will support the structure.

Latest developments in ore bridge design and safety will be incorporated in the new unit. The bucket will be able to handle 15 tons of iron ore in each lift.

NEW FORGE SHOP FOR CALIFORNIA PLANT



The new forge shop at National Supply Co., Torrance, Calif. is the product of intensive planning. New heating furnaces have been provided at each hammer location. Insulated floor pits have been installed for storing finished forgings. Each hammer location is a complete forging unit, readily accessible to carloaders, through the open side of the building. A large annealing pit and an overhead crane serves the entire hammer department. Two presses, a 1200-ton and a 1500-ton, served by an 11-ton manipulator and two heavy-duty overhead cranes make up the press forge department.

PLAN RESTORATION OF HISTORICAL FURNACE

▲ Restoration of one of the earliest industrial landmarks in America, the first iron works and blast furnace to be operated in the New World, is under way at Saugus, Mass. It is expected to be completed and opened to the public late in 1951.

The iron works, which dates from 1644, is being restored as a permanent tribute to the iron workers of colonial days and to their successors, who have increased daily production of the 1640's, one ton of bar iron, to an industry producing over a quarter million tons of steel per day. This unique industrial shrine is expected to attract half a million tourists annually.

Until recently the site at Saugus was a patch of ground overgrown with weeds and brambles, on the banks of the little Saugus river, 10 miles from Boston.

Following clues based on fragmentary records, an archeological crew already has brought to the surface more than two tons of relics of the iron works. They include iron

rings, nails, tools, kitchen utensils and many other objects. A mine detector such as those used in World War II is one means by which the artifacts are being located.

This ancient site might have remained obscure except for the loyalty of Miss M. Louise Hawkes of Saugus, whose ancestors lived there as far back as 1630.

In 1942, graduates of the Ford Trade School bought an old house, formerly the property of a long-dead Saugus ironmaster, with a view of moving it to Michigan as a gift to the late Henry Ford.

Miss Hawkes knew the story of the iron works and believed that what belonged to New England should remain there. She carried her fight to keep the house in Saugus to Governor Saltonstall and with the cooperation of Henry Ford himself, the structure was permitted to remain in New England.

The First Iron Works Association was formed in 1943 with Miss Hawkes elected as one of its charter officers. J. Sanger Attwill of Lynn, Mass., is president. Since then, the organization has carried on its work of restoration of the blast furnaces of colonial days.

AISE PROVIDES EQUIPMENT STANDARDS

▲ Discussing the value of standards for equipment purchased by the steel industry at the semi-annual company member conference of American Standards Association in Pittsburgh, Pa., May 17, I. E. Madsen, standards engineer, Association of Iron and Steel Engineers, said the AISE likes to think of their specialty engineering standards as "rubber" standards, which sometimes can be stretched far enough to become national standards, or squeezed down from an overall standard such as American Standards that are a consensus of all parties interested. However, Mr. Madsen said most steel mill equipment does not fit into a national standards picture, and in some instances an overall standard has had to be modified to meet the steel industry's requirements. He attributed this situation to the fact that a standard, in order to become a consensus of many interests, may have to be modified to the point where it may not fully meet the needs of an industry. The severity of service requirements in the steel industry was given as a major reason for the Association's standardization being on an industry basis.

The AISE embarked on an extensive renewed program of standardization in 1945, using as a basis several hundred suggestions for projects. The selection of desirable projects was by a process of elimination. Those eliminated were the ones that should be done by other groups, those in which existing practice indicated no consensus would be reached, those in which developments were rapid, and those in which further design and engineering data were required. The latter problem led AISE to sponsor several research projects. This procedure left a list of projects with attractive possibilities, some being handled cooperatively with other organizations, particularly NEMA.

Mr. Madsen said manufacturers of equipment for the steel industry are often more anxious to see standard-

SAVE TIME

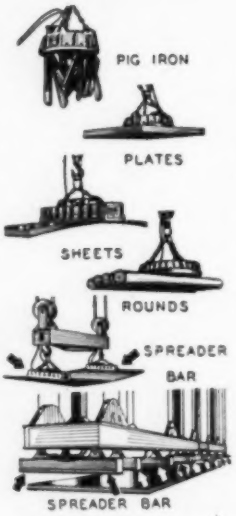
You can cut down the time for loading, unloading and moving hard to handle materials . . . and make a direct saving of hand labor. Whatever your job, STEARNS Lifting Magnets will help you save time and money.

Stearns LIFTING MAGNETS

STEARNS Lifting Magnets are being successfully and profitably used in handling scrap iron, steel plates, coils, bundles, strip steel, rails, slabs, billets, pig iron, castings, borings, turnings as well as finished products. The problem of loading or unloading . . . or moving large quantities of material quickly at a low cost — easily solved with STEARNS Lifting Magnets.

For the efficient handling of flat steel sheets, plates and regularly shaped steel bars and structural steel sections, be sure to investigate STEARNS Rectangular Lifting Magnets.

STEARNS Lifting Magnets pay for themselves in a short time, require surprisingly little attention, and are your best bet for economical, fast and safe moving of material.



Standard sizes available in both bolted and all welded constructions. Special sizes and shapes made to your requirements.

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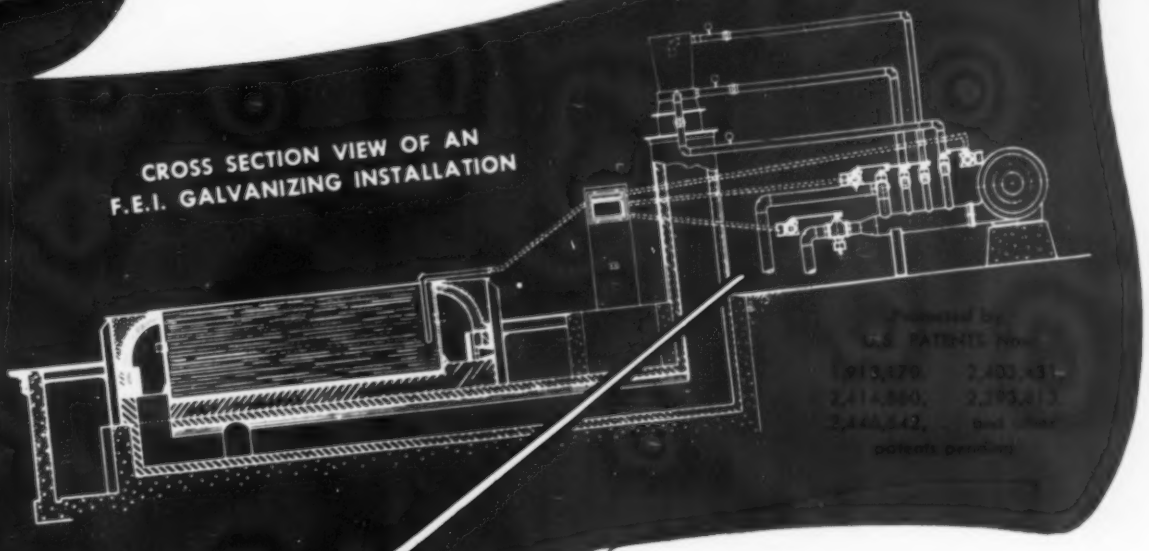
3 REASONS WHY

F·E·I controllable exhaust system

IMPROVES PERFORMANCE



...in Galvanizing

SHEETS—TUBES—METALWARE

SPEEDS UP PRODUCTION! *Automatic OPERATING CONTROL* regulates heat input and exhaust simultaneously . . . The required temperature is reached *faster!*

SAVES FUEL! *Automatic HOLDING CONTROL* holds uniform temperature on *minimum gas flow*, after the desired operating temperature has been reached. Cuts cost of production.

PROLONGS KETTLE LIFE! *Automatic LIMITING CONTROL* limits temperature during periods of low heat requirement and sudden shutdowns. Actual records show kettle life more than doubled or even tripled. Get all the facts . . . how the F.E.I. Controllable Exhaust System has really modernized galvanizing technique.

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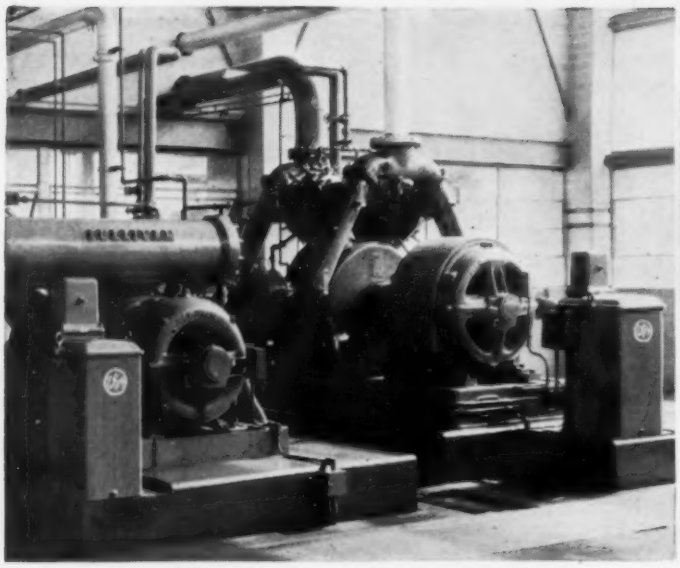
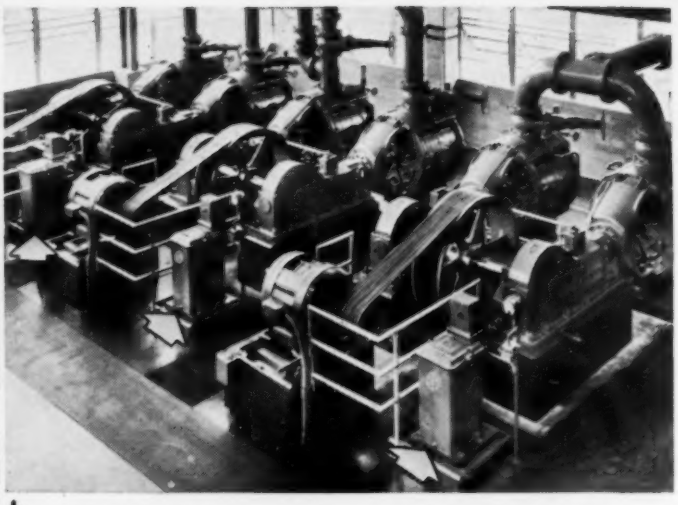




. . . ON AIR COMPRESSORS . . . ON VACUUM PUMPS

In Protected Rooms, in Coastal Atmospheres, in Dusty Locations...

EC&M OIL-IMMERSED MOTOR STARTERS

HELP SPEED PRODUCTION IN GULF COAST PLANT

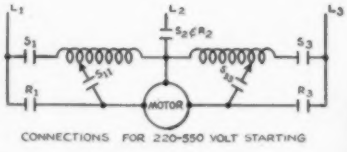
These EC&M reduced-voltage Motor Starters are very popular in industrial plants. *Automatic operation* from push-button stations brings squirrel-cage or synchronous motors up to speed quickly, safely—with greater skill than human hands can do it.

Oil-immersed, the simple double-throw contactor is always well lubricated and protected from corrosion—eliminating the need for frequent inspection or maintenance. Motor circuits are made and broken under oil—thoroughly safe, no dust hazards.

Magnetic overload relays in these starters give inverse-time-element protection and also *trip instantly* on heavy over-currents. A magnetic balance in each relay absorbs heavy starting currents and allows a *low* current-setting for accurate protection under running conditions. EC&M Motor Starters have a reputation for low up-keep cost.

. . ON PROCESS MACHINES

GRAIN RECEIVING STATION



CONNECTIONS FOR 220-550 VOLT STARTING

Complete compensator

Compensator mechanism

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THE ELECTRIC CONTROLLER & MFG. CO.

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ization of their products than the steel industry as a purchaser, but that uncertainty of the demand for a standardized product is a deterrent unless a standardizing agency with adequate representation in the industry indicates the desired specifications and the extent of the demand. To such an agency a manufacturer can initiate or suggest standardization activities, both for new standards and revisions of old ones. Such suggestions are not new. They have resulted in the present d-c mill motor standard, traveling crane specifications, the control standard for auxiliary and accessory machine controllers, and in pending standards of brake wheel sizes.

It was pointed out that standardization of the industry's products is covered adequately by another association, the American Iron and Steel Institute, with which the Association of Iron and Steel Engineers is sometimes confused by non-steel men. AISE is an international professional technical society with headquarters in Pittsburgh and a membership of 4200 individuals.

Three other speakers discussed American Standards Association activities in relation to industry. These were Joseph Manuele, Westinghouse Electric Corp., W. P. Kliment, Crane Co. and W. J. Donald, National Electrical Manufacturers Association.

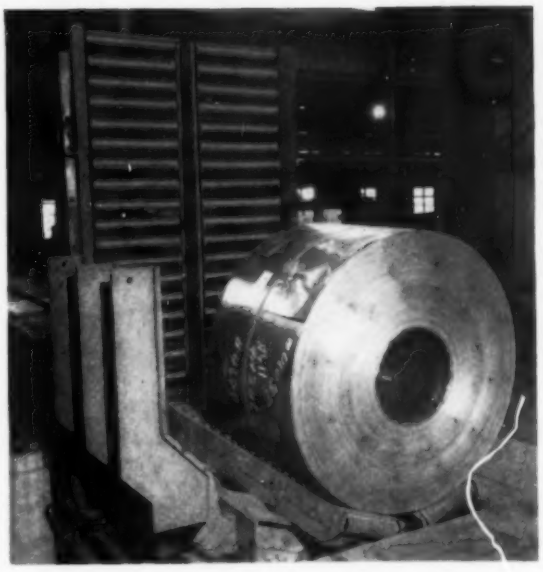
Presiding at the conference was CMC Chairman E. W. Gardinor, International Business Machines Corp. The conferees were welcomed to Pittsburgh by Thomas D. Jolly, Aluminum Co. of America, and president of American Standards Association.

TRUMBULL ELECTRIC TO OPERATE REGIONALLY

▲ According to a recent announcement, the Trumbull Electric Mfg. Co. of Plainville, Conn., has put into effect a new plan of organization under which the company's marketing department will operate on a regional basis. Under this new plan, over-all company marketing activities will be carried on in each of four geographical regions under the direction of regional managers.

Richard C. Lipps has been appointed eastern regional manager, and in this capacity is responsible for all marketing activities of the Trumbull Co. in the East, which includes field

WHAT MAKES THE DIFFERENCE in conveying equipment?



● **Experience**—A solid background of conveyer jobs that were difficult and diverse. That's what makes the difference in the conveying equipment you buy. If it is going to satisfy you, the equipment must be designed with your problem in mind. It must have the weight and strength built into it if it is to stay on your job. Mathews Engineers have the type of experience that makes the difference. There are nearly 50 years of it, backed up by the facilities of three modern, strategically located plants, each specializing in conveyers and conveyer systems that are engineered to serve production. Let us make your conveying problem our business. **Write today for bulletins or engineering service.**

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GENERAL OFFICES . . . . . *Mathews Conveyer Company*
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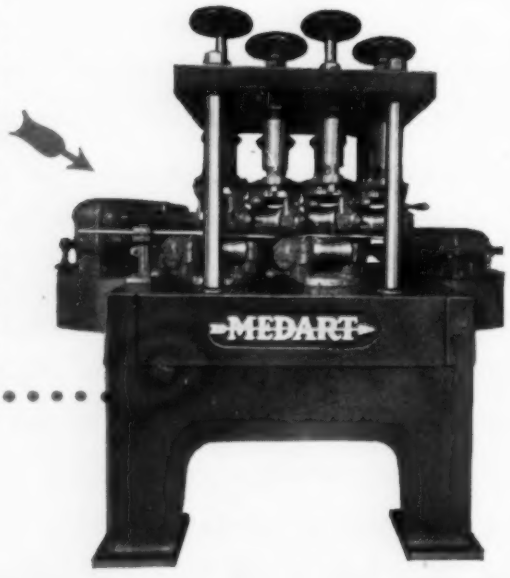
MEDART MICRO-MULTICYCLE!

straightening machine designed exclusively for ⅛" to ½" bars and tubing.

Small, compact yet built on the same principle and embodying the same advantages as the Medart 6-in-1 Multicycle Straightener . . . positive, synchronized feed . . . one feeding level . . . two bending cycles . . . single motor . . . and the Medart Micro-multicycle has this PLUS FEATURE: all six rolls are driven! A variable feed-speed range is built into the machine. 3 H. P. motor mounted on base of machine.



MANUFACTURING ENGINEERS OF COMPLETE TRANSMISSION EQUIPMENT AND SPECIALIZED MACHINERY

MEDART

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sales districts and sales engineering functions from Maine to Georgia. Allan A. Watson has been appointed central regional manager which gives him responsibility for marketing activities in the middle west and south, including field sales districts and sales engineering functions extending from Western Pennsylvania to Colorado as far north as Canada. Trumbull's marketing activities in the California region, which includes all of California and Arizona and part of Nevada, will be under the direction of J. Warren Barry, who has been moved up from his position as California operations manager.

The northwest region, covering all of Washington, Oregon, and Idaho, and parts of Nevada, Colorado, and Montana, will be under the managership of Willis I. Downie.

BYERS WILL MARKET WROUGHT IRON SHEET

▲ To help satisfy the current demand for metal sheet, A. M. Byers Co., Pittsburgh, Pa., will again make wrought iron sheet available. These have not been on the market since the war.

Flat and corrugated hot rolled annealed wrought iron sheet, black as well as galvanized, from 8 gauge to 22 gauge, is now available.

A new American standard, high strength, high temperature internal wrenching bolts, is announced by the American Standards Association. As the name indicates, these bolts are intended for applications where high strength is required under high temperature conditions, such as in steam turbine assemblies. The bolts have a round head with a hexagonal recess, the head being larger than that of regular socket head screws. When the round bolt head is located in a counterbore it may be peened to lock it against rotation.

The American Standard lists bolts in nominal diameters from ⅜ to 2 in. bolts up ⅞ in. inclusive have coarse threads, and larger bolts, 8-pitch threads according to the American Standard B1.1-1949.

FEI NAMES KRAFT AS CHICAGO REPRESENTATIVE

▲ Furnace Engineers, Inc., Pittsburgh, Pa., announce that Ralph B. Kraft, Chicago sales representative, will now represent them in the entire

midwest territory. In making the announcement, Harry Dobrin, president of Furnace Engineers, Inc., pointed out that Kraft & Co. is well qualified by long experience to represent the company in serving the industrial furnace needs in the midwestern field.

Furnace Engineers, Inc. has greatly expanded its activity in this area, particularly in the design and construction of new, improved type galvanizing furnaces for galvanizing tubes, sheets, wire and metalware. "F.E.I." installations also include direct-fired cover furnaces for sheet and coil annealing, continuous bloom, billet and slab furnaces, open hearth furnaces and soaking pits.

Headquarters of Ralph B. Kraft, sales representative, are at 9925 South Hamilton Ave., Chicago 43, Ill.

B&W TO ENTER TUBE FABRICATION FIELD

▲ Plans to enter the field of limited fabrication of seamless and welded tubing, in addition to its primary work of manufacturing such tubing, were announced by Babcock & Wilcox Tube Co., Beaver Falls, Pa.

E. A. Livingstone, vice president, explained that "upon special request we have in the past done certain fabrication work for customers on a job basis but growing demands to have basic fabrication of tubes done by the manufacturer instead of necessitating shipment to another plant has prompted us to form a department for this type of work."

The types of fabrication to be handled under the new policy, Livingstone said, will include bending; end forming such as swaging, upsetting, flaring and expanding; flash-butt-welding for safe-ending and making long length tubing; the production of tubing with various cross section shapes and other specialty tube work.

HEPPENSTALL MOVES CLEVELAND OFFICE

▲ The Cleveland district sales office of Heppenstall Co., Pittsburgh, Pa., has been moved from 311 Rockefeller Building to more convenient quarters at 506 Terminal Tower Building. R. E. O'Brien is the Cleveland district sales representative for this steel forgings manufacturer.

AMONG AIR CLUTCHES

ONLY FAWICK

PROVIDES ALL THESE FEATURES

360° RADIAL CONTACT—Application of the operating pressure at the maximum diameter results in the greatest operating torque.

AXIAL CONTACT—Fawick design provides uniform-pressure, constant-velocity contact between the full width of the friction shoes and the drum.

SHOCK ABSORPTION—Operating torque is transmitted through the flexible rubber tube, dampening shaft vibrations and cushioning peak load shocks.

CONTROLLED TORQUE—Variation of operating pressure makes sensitive control of applied torque possible. Peak overload protection is assured at a selected air pressure.

For specific information on all advantages of Fawick Industrial Clutch and Brake Units, write to the Main Office, Cleveland, Ohio, for Bulletin 300.

All desirable clutch characteristics are built into Fawick Airflex units

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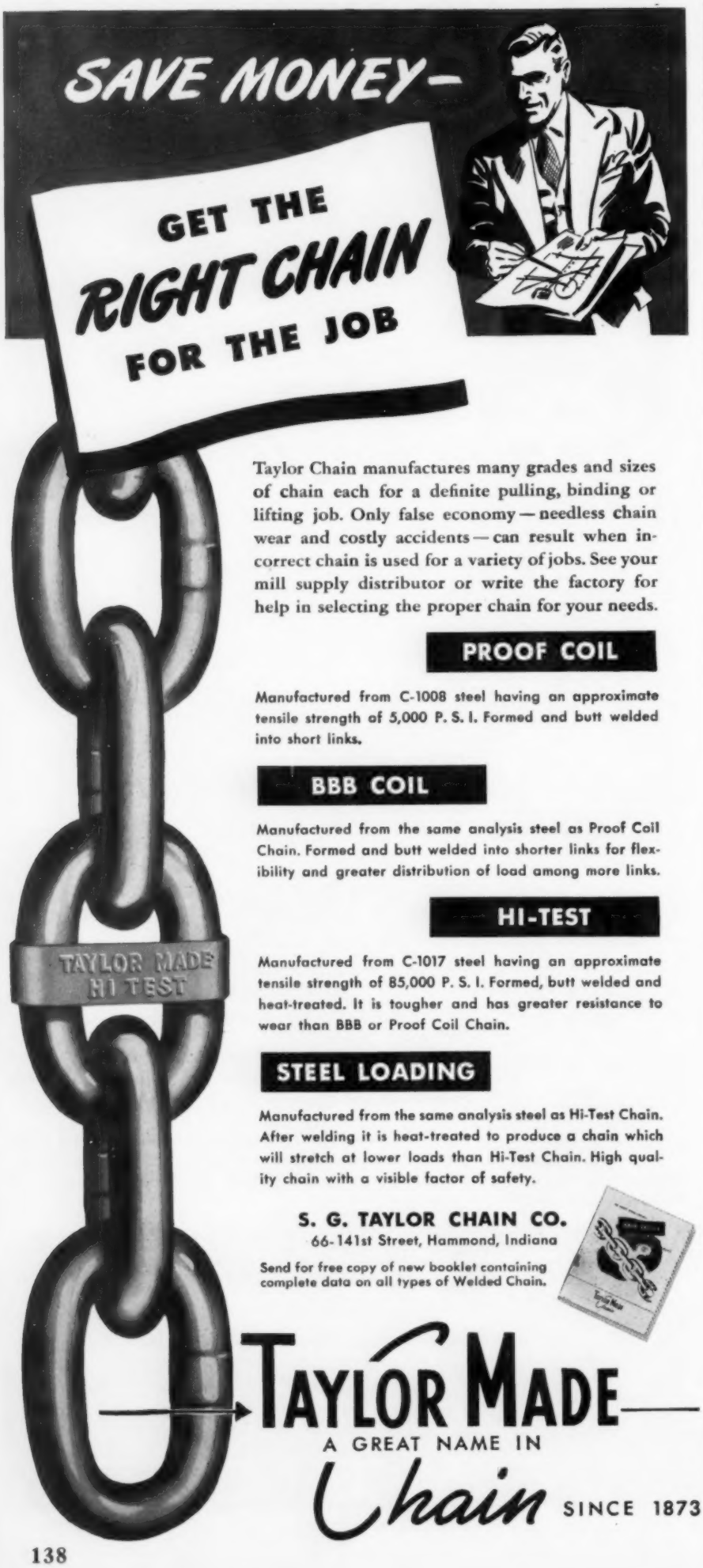
FAWICK CLUTCHES = + + + = PEAK EFFICIENCY
AXIAL CONTACT 360° RADIAL CONTACT SHOCK ABSORPTION CONTROLLED TORQUE



Taylor Chain manufactures many grades and sizes of chain each for a definite pulling, binding or lifting job. Only false economy — needless chain wear and costly accidents — can result when incorrect chain is used for a variety of jobs. See your mill supply distributor or write the factory for help in selecting the proper chain for your needs.

PROOF COIL

Manufactured from C-1008 steel having an approximate tensile strength of 5,000 P. S. I. Formed and butt welded into short links.

BBB COIL

Manufactured from the same analysis steel as Proof Coil Chain. Formed and butt welded into shorter links for flexibility and greater distribution of load among more links.

HI-TEST

Manufactured from C-1017 steel having an approximate tensile strength of 85,000 P. S. I. Formed, butt welded and heat-treated. It is tougher and has greater resistance to wear than BBB or Proof Coil Chain.

STEEL LOADING

Manufactured from the same analysis steel as Hi-Test Chain. After welding it is heat-treated to produce a chain which will stretch at lower loads than Hi-Test Chain. High quality chain with a visible factor of safety.

S. G. TAYLOR CHAIN CO.
66-141st Street, Hammond, Indiana

Send for free copy of new booklet containing complete data on all types of Welded Chain.

TAYLOR MADE
A GREAT NAME IN
Chain SINCE 1873

BEGIN CONSTRUCTION OF NEW J&L FURNACES

▲ A ground breaking ceremony was held May 18 at Thirty-second and Carson Streets, Pittsburgh, Pa., for the new open hearth plant of the Jones & Laughlin Steel Corp. The new open hearth shop will consist of six 250-ton stationary furnaces and all the necessary corollary facilities. The building housing the open hearth furnaces will be 880 ft long, exclusive of the mixer building on the down-river end. Provision has been made for future addition of five more similar open hearth furnaces on the up-river end. The stockhouse located beyond the area allocated for the five future furnaces will be 880 ft long; the mold conditioning building and cinder yard, 1072 ft long; and the stripper building, 307 ft long. The additional property for this project which lies north of East Carson Street is 49 acres.

The new shop will have an annual capacity of one million tons of high quality steel. It will permit the abandonment of high cost obsolete No. 1 open hearth shop which consists of four small stationary furnaces and the Soho shop which consists of six 65-ton furnaces.

Engineers and supervisors for the project will be Swindell-Dressler Corp. The furnaces will be built by Loftus Engineering Corp. The foundation contractor, Morrison-Knudsen, will begin work immediately. It is expected that some of the furnaces will be in operation in the fall of 1951. The new plant should be in full operation early in 1952.

PALMER-BEE MOVES PITTSBURGH OFFICE

▲ Palmer-Bee Co. has changed the location of the Pittsburgh, Pa., office, effective May 1 to the 12th floor of the Peoples East End Building, Pittsburgh, Pa. In this new location they will be more advantageously located to render sales and engineering service to their many customers.

BUILD SINTER PLANT AT RANKIN FURNACES

▲ Steel framework for another new U. S. Steel sinter plant changes the Monongahela river skyline at Rankin,

The new sinter plant will add more than a million net tons of high grade ore available.

Pa. This improvement at Carrie furnaces of Carnegie-Illinois Steel Corp. is one of three new plants in the Pittsburgh district for the recovery of iron from blast furnace flue dust. One at the McKeesport, Pa. plant of National Tube Co. is now operating. The sinter plants will add more than a million net tons a year to the high grade iron ore available for U. S. Steel blast furnaces here, without requiring an equivalent increase in iron mining.

ELECTRIC PRODUCTS NAMES NEW AGENT

▲ Electric Products Co., Cleveland, Ohio has appointed Vincent J. Brown Co. as district representatives for New York State with the exception of metropolitan New York City.

Vincent J. Brown Co. maintains offices in Buffalo and Syracuse, N. Y. and will be responsible for promoting Electric Products Co. line of synchronous and induction motors, a-c and d-c motors and generators, battery chargers, electrolytic power supplies and frequency changers.

NATIONAL TUBE WINS HIGH SAFETY AWARDS

▲ Long work records without a lost-time accident have won the National Safety Council's highest award for two McKeesport, Pa., plants of U. S. Steel's National Tube Co.

The 7100 employes at National works piled up 2,945,000 manhours of working time without an accident requiring any employe to be off the job. The plant operated 77 accident-less days in compiling the record. This is the second year in a row that

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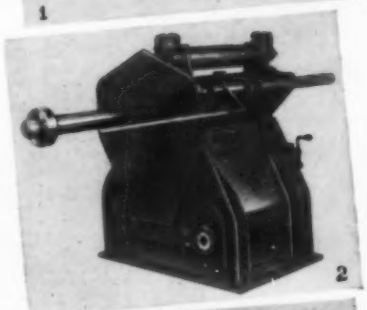
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3

1: Slitting unit and scrap cutter, self-contained in welded steel base, with tilting entry guide.
2: Winder with variable speed transmission and power stripper.
3: Discharge buggy with motor-operated elevator.

3 GANG SLITTING LINES Increase Production in the Detroit Branch of AMERICAN BRASS COMPANY

Three identical, high-speed slitting lines designed for light gauges, have been installed to replace old equipment in American Brass Company's Detroit branch. This heavy duty machinery combines famous Torrington standards — advanced design, dependable accuracy and the ability to withstand abuse under continuous heavy service. This machine combines slitting unit and scrap cutter, winder and discharge buggy. Outstanding features are:

- Speed adjustable from 335 to 1005 feet per minute
- Anti-friction bearings
- Tilting entry guide for complete access to front of slitter in setting up
- Rotary head on blocks scrap cutter
- Arranged for winding metal on various diameter mandrels
- Variable speed transmission in winder to accommodate different winding diameters
- Adjustable tension on metal being wound
- Air-operated stripper to remove finished coils
- Motor-operated elevator on discharge buggy

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DESIGNERS AND BUILDERS OF MILL MACHINERY FOR OVER 60 YEARS

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Christy Park works set a record of 1,121,862 manhours of work without lost-time mishap. The plant's 500 employes were on the job 386 safe working days in setting the mark.

AMERICAN CAN MOVES HEADQUARTERS OFFICE

▲ American Can Co. has completed the removal of its general headquarters staff and facilities in New York. N. Y., to 100 Park Avenue. The move also included the Atlantic division sales and the Metropolitan sales organizations.

AMERICAN MAGNESIUM TO BECOME INACTIVE

▲ Manufacturing activities of American Magnesium Corp., the magnesium fabricating subsidiary of Aluminum Co. of America (ALCOA), was assumed by ALCOA, effective June 1, 1950, and American Magnesium Corp. will become inactive on that date.

Operations of American Magnesium Corp. have been conducted at Cleveland, Ohio, and Buffalo, N. Y., and will be continued there under ALCOA management. Additional magnesium fabricating activities are conducted by ALCOA at several other locations, and these operations will continue as they are.

Inasmuch as ALCOA'S sales department has been the sales agent for American Magnesium Corp., there will be no change in selling activities.

CLAIRTON WORKS TO GET 174 NEW COKE OVENS

▲ Construction of two new coke batteries of 87 ovens each at Clairton, Pa., works of Carnegie-Illinois Steel Corp. replacing two batteries of old ovens, has been scheduled. Contract for the work has been awarded Koppers Co., Inc., it was announced.

Actual construction of the first new battery is expected to get underway early in September, with work on the second starting about 60 days later. The batteries are scheduled to go into operation about one year after the start of construction work.

The new by-product ovens will be of the underjet type, designed for coke-oven gas heating, with re-circulation of waste gases. The batteries will carbonize 5000 tons of coal every 24 hours, yielding approximately 3300 tons of coke in the same period.

Clairton works contains 1567 ovens which recover chemicals and gas during the coking of coal.

ALLEGHENY ANNOUNCES NEW IMPROVEMENTS

▲ Allegheny Ludlum Steel Corp. has announced a new $23,600,000 plant improvement program, to be completed in the next three years. This program is in addition to a five-year program costing $30,000,000 started immediately after the war and now in the final stages of completion.

Principal need for the new program is to keep the company's manufacturing facilities in step with ever-changing and increasing demands for high alloy steels and electrical steels. The new improvements will more fully integrate Allegheny Ludlum's operations and supplement the new electric furnace melting facilities and

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ALL through the summer—through hot, humid days and hot, humid nights—the biggest thief in America will be raiding your plant. Wherever steel is handled—where it is stamped and milled or machined or ground, where it is pickled or cleaned or assembled—RUST will be busy, robbing you of production, robbing you of profit.

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rolling mills. At the same time they would widen the company's product range while improving quality and lowering costs.

Manufacturing improvements include a new hot strip mill and additional cold rolling facilities at the Brackenridge plant and additional cold rolling equipment at the neighboring plant at West Leechburg, Pa.

The new program also includes a project calling for the erection near Brackenridge, Pa., of a new research laboratory to be built of stainless curtain-walls instead of the more conventional building materials. The new building, overlooking the company's Brackenridge plant, will provide the latest facilities for all phases of metallurgical research into high alloy and other specialty steels.

INLAND PICKLING LINE TO BE FINISHED SOON

▲ Electrical equipment, including drives, control, switchgear, and auxiliaries, is being supplied by General Electric for the Inland Steel Co.'s new 60-in. pickling line. The new line, which will increase capacity for the production of sheet-steel for the company's Indiana Harbor, Ind. plant, is expected to be in operation by next fall.

An unusual provision of the new line is that it will use shallow immersion on the delivery end, instead of the deep immersion normally used. This will be made possible through the use of twin rolls in the pickling tanks combined with General Electric amplidyne control. In the usual deep tank, the catenary loop is maintained by the strip slack, which is controlled either by a dancer roll or magnetic detector unit. In the shallow immersion to be used on the new line, the twin rolls will be in fixed position to maintain a constant position, and delivery tension will be held through the use of amplidyne control. This tension, once preselected by the operator, will be maintained automatically for all strip speeds throughout the operating range.

Additional equipment to be supplied by General Electric will include adjustable voltage d-c control for the process motors and pinch roll motors, as well as for the side trimmers and upcoiler. Constant voltage direct-current control will be used for the 40-foot entry conveyor, scrap chopper, delivery conveyor, and rewind motors. The main process line, consisting of group assembled a-c motors designed for steel mill operation, will be controlled by G-E Milltrol, operating from 440-volt a-c plant supply lines.

The main motor-generator set will consist of a six unit combination including a 1250-hp, 6600-volts, 750-rpm synchronous driving motor, two entry end generators, two delivery end generators, and one general purpose exciter generator. This will allow complete individual control of each of the main line sections without interaction between sections. However, all sections will be held in coordination to provide desired strip tensions throughout the required strip speed ranges by means of a completely integrated master control system.

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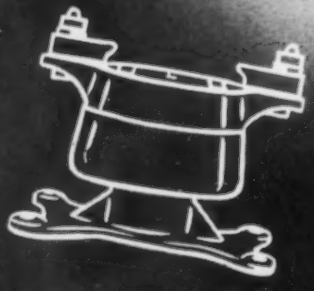
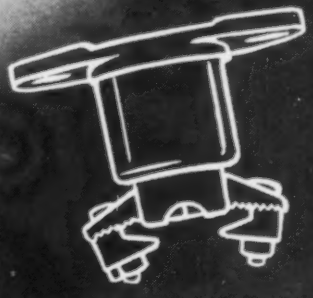
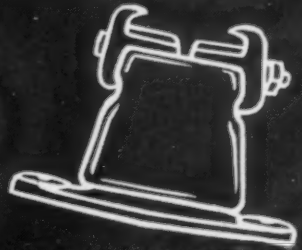


Type DD Keystone Contact Rail Insulator for over-running service. Glazed semi-porcelain block insulator. Takes 30- to 100-lb standard rail sections.

Type BO Keystone Contact Rail Insulator for over-running service at 750 volts or less, where great mechanical strength is required.



Type PGB Keystone Contact Rail Insulator, for under-running service. Weather-proof porcelain insulator housing, compact mica insulation.



Types HA and I Keystone Contact Rail Insulator — Cast iron base, cemented at factory to porcelain insulator. All metal parts are hot galvanized.

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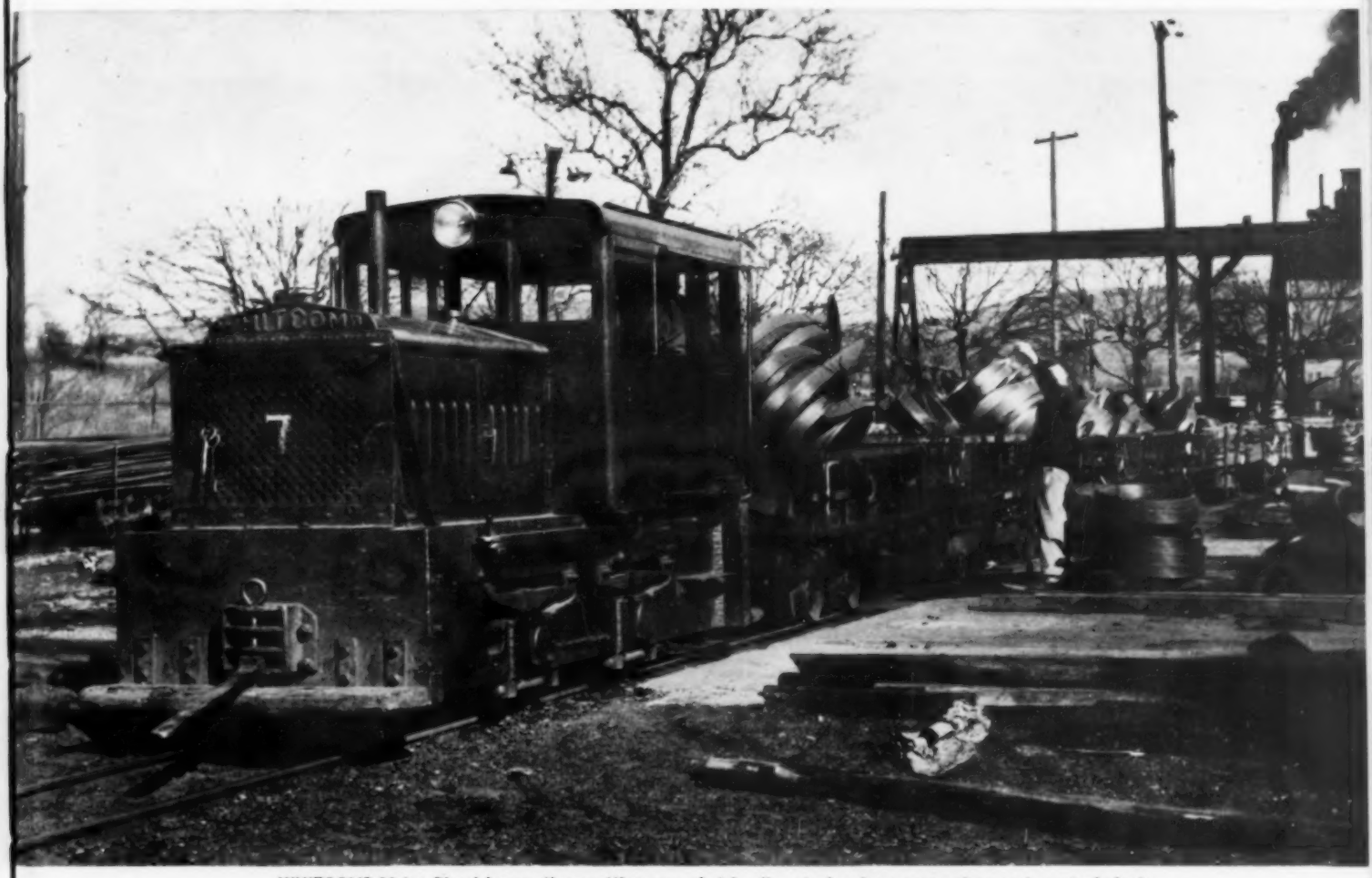

WHITCOMB 10-ton Diesel Locomotive spotting cars of strip alloy steel under a crane at an eastern steel plant. This is one of the first of eleven Whitcomb Industrial Diesels put into operation by this steel plant since 1917.

The highest testimonial you can give a product is to reorder. And eleven times since 1917 an important eastern steel plant has paid this compliment to Whitcomb locomotives. The first order, 32 years ago, was for a 4½-ton gasoline locomotive; the latest order, in 1948, called for two custom-built 10-ton Whitcomb Diesels.

The design, the engineering, the equipment of Whitcomb Industrial Locomotives has changed a great deal since 1917. But one thing has remained constant — QUALITY. For it has always been the Whitcomb policy to build the *finest* locomotive of its kind, the *best* locomotive of the times. That's why throughout the steel industry today you'll find modern Whitcomb Diesels working beside Whitcomb models built a generation ago. A Whitcomb is hard to wear out.

Write us today for full information on Whitcomb Locomotives — Diesel mechanicals from 3 to 30 tons; Diesel electrics from 25 to 95 tons.

There is no power more economical than Diesel; no Diesel locomotive finer than a Whitcomb.

Whitcomb 10-ton Diesel, in switching operation, hauls bars and rods to storage.

Whitcomb 10-ton locomotive switching hoppers of ferro-chrome to the electric furnaces.

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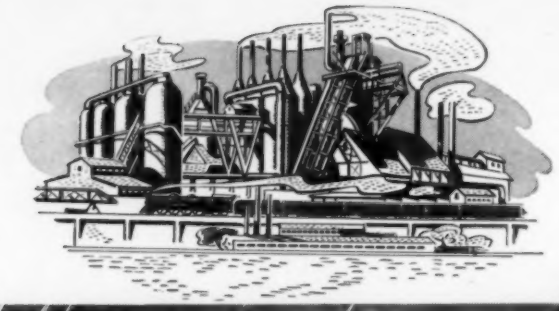

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Personnel News...

Fred M. Gillies was elected executive vice president of Acme Steel Co., Chicago, Ill. Mr. Gillies, a steel executive with years of experience, had formerly been works manager for Inland Steel Co. from 1922 up to a few months ago; prior to that he was with the old Illinois Steel Co. from 1920 to 1922. He is a Cornell University graduate of 1918 and was a World War I Naval aviator. The position of executive vice president of Acme Steel Co. has been unfilled since **Chester M. MacChesney** was elected chairman of the board in the fall of 1949.

Charles A. Butcher was named assistant to the president of Worthington Pump and Machinery Corp., Harrison, N. J. Mr. Butcher formerly was general manager of Crocker-Wheeler Electric Manufacturing Co., and vice president of its successive parent companies, Joshua Hendy Corp. and Elliott Co. He will make his headquarters at 2 Park Avenue, New York, N. Y.

Norm J. Kirk and **Robert Potter** were elected vice presidents of E. W. Bliss Co., Toledo, Ohio. Mr. Kirk is manager of the Toledo division where heavy forming presses are made. Mr. Potter is manager of the company's rolling mill division at Salem, Ohio.

H. P. Richter has been appointed manager of real estate of United States Steel Corp. of Delaware, Pittsburgh, Pa. A native of Chicago, Mr. Richter was graduated from Armour Institute of Technology in 1932 with a bachelor of science degree in civil engineering. After five years experience in the general real estate field, he joined U. S. Steel in 1937 as assistant to manager of real estate for Carnegie-Illinois Steel Corp. in Chicago, Ill. He was transferred to the general office of Carnegie-Illinois in Pittsburgh in 1941 as assistant to manager of real estate and for the last year has been in charge of real estate for the company.

H. G. Irons was named manager of the real estate division of Carnegie-Illinois Steel Corp., Pittsburgh, Pa. and **J. O. Cook** was appointed assistant manager of the division. Mr. Irons comes to Pittsburgh from the company's Chicago offices, where he has been assistant secretary of Carnegie-Illinois since 1935. He started with the former Illinois Steel Co. in 1909 at Chicago, and was in charge of that company's real estate before its acquisition by Carnegie-Illinois. Mr. Cook started with the company in 1940 as an engineer, and since March 1941 he has been chief real estate engineer.

Clair C. Finley was made chief draftsman of the engineering department at the Midland, Pa. works of Crucible Steel Co. He succeeds **L. G. Pearce,** who retired after 24 years with the company.

Earl V. Harlow has been appointed engineering assistant to the vice president and general manager of the metal products division of Koppers Co., Inc. Formerly associated with Koppers central Research Department, Mr. Harlow in his new assignment will be responsible for assisting and advising the division general manager on engineering matters, and for coordinating research and development projects between the division and the research department.

Dr. Roman Smoluchowski has been promoted to professor of metallurgical engineering at Carnegie Institute of Technology, Pittsburgh, Pa., effective September 1, 1950. Professor Smoluchowski holds an M.A. degree from the University of Warsaw, Poland, and a Ph. D. from the University of Groningen, Holland. Before joining the Carnegie faculty in 1946, he was a research physicist with the research laboratory of General Electric Co.

Vernon W. Jones was appointed superintendent of steel production; **William Bergman** was named superintendent of No. 1 open hearth department, and **Edgar R. Westfall,** becomes assistant open hearth superintendent at the East works of Armco Steel Corp., Middletown, Ohio. Mr. Jones joined Armco in 1928 with an extensive background of electric furnace operation, as assistant to superintendent of the open hearth department. He was appointed general foreman of electric furnace operation in 1930, assistant superintendent, open hearth department the following year and superintendent of that department in 1943. Mr. Bergman's first connection with Armco was as a designer in the drafting department in 1928. Placed on special assignment as an open hearth engineer in 1936, he was advanced to assistant to open hearth superin-

FRED M. GILLIES

CHARLES A. BUTCHER

ROBERT POTTER

NORM J. KIRK

tendent in 1943. Two years later he was named assistant superintendent of that department. Mr. Westfall joined Armco in 1934 as a laborer in the employment reserve. The following year he was transferred to the open hearth department and advanced through several positions there and also in the masonry department. He was appointed superintendent of the masonry department in 1949.

Charles A. Dostal, vice president of Westinghouse Electric Corp. since mid-1943, retired recently after completing more than 43 years service with the company.

Albert J. Maslin has recently been appointed assistant to the engineering manager of the Westinghouse Electric Corp., transformer division at Sharon, Pa. In his new assignment, he will continue to head the general transformer development section and in addition will be responsible for transformer insulation development and coordination of many other engineering projects at the Sharon plant.

John M. Urban, foundry superintendent and metallurgist for the Fanner Manufacturing Co., Cleveland, Ohio, since 1939, has been appointed a technical service representative in the coke sales department of Diamond Alkali Co.

Robert G. Page has been named designing engineer of the Trumbull Electric Manufacturing Co. of Plainville, Conn. Mr. Page who has been with Trumbull for two years, has been advanced from supervisor of the navy design section. In his new job, he will be responsible for product design and development, product evaluation and standardization. He will also serve as chairman of the patent committee.

Edmund F. Martin has been appointed general manager of the Lackawanna, N. Y., plant of Bethlehem Steel Co., succeeding **A. H. Shonkwiler,** who has resigned. Mr. Martin has been with Bethlehem since 1922. He became superintendent of the Grey mill at the Bethlehem plant in 1928, and assistant superintendent of the Saucon division in 1939. In 1946 he was made assistant general manager of the Lackawanna plant. He has been acting general manager since the first of the year.

R. W. Berg has joined the sales staff of National Roll and Foundry Co., Avonmore, Pa. Mr. Berg, a graduate of the University of Pittsburgh, has been associated with the steel industry for a number of years. He was

RICHARD W. BERG

with the Carnegie-Illinois Steel Corp., Mesta Machine Co., and until recently was Pittsburgh district sales manager of the Torrington Co.

John N. Welsh, director of engineering service of Hall Laboratories, Inc., Pittsburgh, Pa., since 1939, has been named associate director of the firm. Mr. Welsh will continue as director of engineering service.

John W. Lohnes, formerly manager of sales for the International Graphite and Electrode Corp., has been appointed vice president in charge of carbon and graphite sales for Speer Carbon Co., and its subsidiary, International Graphite and Electrode Corp. both of St. Marys, Pa. **William E. Harvey,** formerly plant manager of International Graphite and Electrode Corp. at Niagara Falls, N. Y., has been appointed plant manager of all carbon and graphite plants of the parent company, Speer Carbon Co., St. Marys, Pa. and its subsidiaries. **Robert E. Rice,** has been appointed sales manager of International Graphite and Electrode Corp., St. Marys, Pa. Mr. Rice was formerly assistant sales manager of International Graphite and Electrode Corp.'s parent company, Speer Carbon Co.

J. William Schulze has been elected president of the Pennsylvania Crusher Co., succeeding **William S. Newell,** chairman of the board of the Bath Iron Works Corp., the parent company. Mr. Schulze is vice president of the Bath Iron Works Corp. **John A. Plimpton**

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was elected vice president. He has been division manager since June 1, 1949. **John R. Newell,** president of the Bath Iron Works Corp., also was elected vice president of the Pennsylvania Crusher Company.

Albert P. Hayden becomes superintendent of wire rope and tramway engineering and **John A. Herr** advances to the position of assistant superintendent of

ALBERT P. HAYDEN

this department for American Steel and Wire Co., Worcester, Mass. In his new capacity, Mr. Hayden succeeds **Gordon H. Bannerman,** nationally known aerial tramway engineer, who recently became manager of a newly created tramway division of Columbia Steel Co., western subsidiary of United States Steel.

Charles Edison, president of Thomas A. Edison, Inc., for the past 24 years, was elected to the newly created position of chairman of the board of directors, and **Henry G. Riter, III,** was elected to succeed Mr. Edison as president.

Marshall E. Cusic was named district sales engineer for Chain Belt Co. with headquarters at the Pittsburgh district office, 1101 Grant Building, Pittsburgh, Pa.

Harry E. Holman, formerly assistant supervisor of training at Pittsburgh, Pa., works, Jones & Laughlin Steel Corp., was appointed labor relations assistant.

HARRY E. HOLMAN

Mr. Holman received his bachelor of science degree from California State Teacher's College. He received the degree of master of education from the University of Pittsburgh in 1938 and since then has done further

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Bethlehem Steel Corporation
  Bethlehem, Lackawanna, Steelton, and Sparrows Point
Birmingham Slag Company
Canadian Carborundum Company
Carnegie-Illinois Steel Corporation
  Gary, South, and MacDonald Works
Colorado Fuel and Iron Company
Columbia Steel Corporation
Electro-Metallurgical Company
Ford Motor Company
  Detroit and Candian Plants
Geneva Steel Corporation
Great Lakes Steel Corporation
Inland Steel Company
Jones and Laughlin Steel Corporation
Kennecott Copper Company
Keystone Steel and Wire Company
Laclede Steel Company
McClouth Steel Corporation
National Tube Company
  Lorain and McKeesport Works
Northwestern Steel and Wire Company
Pittsburgh Metallurgical Company
Reynolds Alloy Corporation
Republic Steel Corporation
  Cleveland
Rotary Steel Company
Southern Acid and Sulphur Company
Stanley Works, American Tube and Stamping Plant
Timken Roller Bearing Company
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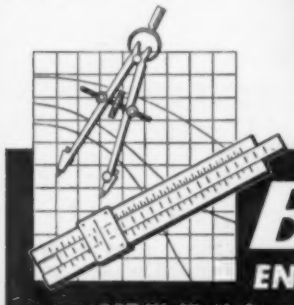

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857 W. North Avenue Pittsburgh 12, Pa.

work at Pitt on the graduate level. He joined the J&L's Pittsburgh works in 1941 as a welder and served as a construction foreman and as an expeditor-estimator. In August, 1946 he was appointed supervisor of foreman instruction in the training department, Pittsburgh works, and in April, 1948 was appointed assistant supervisor of training.

F. C. Senior is now associated with Freyn Engineering Co., subsidiary of Koppers Co., Inc. Mr. Senior is a native of Philadelphia, Pa. After graduation from Penn State in 1936 he joined the engineering department of Bethlehem Steel Co., Bethlehem,Pa., and was engaged in engineering and research activities. He was appointed assistant chief engineer in 1944 and served in that capacity until 1946 when he joined Koppers Co., Inc., as chief engineer of the metallurgical department and was assigned to the Chilean steel mill project in New York, N. Y. Mr. Senior acted as chief engineer of Corporation de Fomento for Koppers Co., Inc., for the steel plant now going into production at Concepcion, Chile, until his recent transfer to Freyn.

Stanley J. Sarek was appointed superintendent of blast furnaces and **James A. Gaugler,** assistant superintendent of blast furnaces for the Hanna Furnace Corp., Buffalo, N. Y.

Gene D. Sickert was appointed works manager of the Indianapolis, Ind., plant of the Peerless Pump division, Food Machinery and Chemical Corp.

Blake C. Hooper was appointed to the sales staff of P. W. Voss and Associates, 918 South Michigan Avenue, Chicago, Ill. The Voss organization is Chicago area sales representative for the Automatic Transportation Co.

E. W. Connolly has been appointed sales manager of the Detroit, Mich., district of Haynes Stellite division, Union Carbide and Carbon Corp. Mr. Connolly is a graduate mechanical engineer of the University of Detroit and has been associated with the Haynes Stellite division for 11 years as sales engineer in the Detroit district. He succeeds **R. D. Gunther,** who has retired.

W. A. Darrah, president of Continental Industrial Engineers, Inc., Chicago, Ill., was awarded a certificate of life membership in the Hall of Flame, an honorary organization of the American Gas Association.

I. L. Case was transferred from the Cleveland, Ohio, office of Dingle-Clark Co. to their Pittsburgh, Pa., office. After completing a course in electrical engineering at the South Dakota State College, Mr. Case received training with one of the large electrical manufacturers and following that he was connected with Weirton Steel Co. in an electrical engineering capacity. Since the early part of 1946, Mr. Case has been with Dingle-Clark actively associated in electrical construction work on such projects as steel mill, coal preparation, ore handling plants, and other types of heavy industries.

Tom Turner, who joined the Westinghouse Electric Corp. in 1922 as a machinist at the East Pittsburgh, Pa., works, has been elected a vice president. He will continue to direct the activities of the elevator division at Jersey City, N. J., where he has been general manager since 1948.

R. H. Olson, formerly vice president in charge of sales of Electric Machinery Manufacturing Co., Minneapolis, Minn., was recently elected president of the

company. He succeeds **W. H. Feldmann** who joined the Worthington Pump and Machinery Corp. as vice president in charge of sales. Electric Machinery is a subsidiary of Worthington. **A. P. Burris,** formerly manager of the New York sales district was elected vice president in charge of sales for Electric Machinery Manufacturing Co. to succeed R. H. Olson. **P. L. Shawley,** of the New York office, has been appointed New York district sales manager.

Glenn R. Kraus and **Ernest C. Hawkins** are now associated with Rees Machinery Co., 1012 Empire Building, Pittsburgh, Pa. Mr. Kraus was formerly with Mesta Machine Co. and Motch & Merryweather Co. Mr. Hawkins was previously with LeMaire Tool & Manufacturing Co., John S. Barnes Corp., and Evans Tool Co.

Ronald E. Grinder was named factory representative for Adalet Manufacturing Co. in the Pittsburgh, Pa., area.

H. G. Ebdon and **William P. E. Ainsworth** have been elected vice presidents of Combustion Engineering-Superheater, Inc., N. Y., N. Y.

H. M. Rich, Jr., has been appointed division vice president of the Electro Metallurgical division, Union Carbide and Carbon Corp. Mr. Rich will make his home and headquarters in Pittsburgh, Pa., and will have the responsibility of general sales management. **W. H. Ferguson,** who has been sales representative in the New York area, has been promoted to eastern manager and will assume the responsibility for the sale of Electromet products in the eastern seaboard and Birmingham areas. **Robert W. Crozier,** who has been engaged in ferro-alloy activities with Electromet, has been appointed a sales representative in the Pittsburgh area and will establish his headquarters there.

Gordon S. Schuhmacher has been appointed district manager in Los Angeles, Calif., for Hagan Corp., Pittsburgh, Pa., combustion and chemical engineering firm, and its subsidiaries, Calgon, Inc., Hall Laboratories, Inc., and Buromin Co. He succeeds **R. L. Sullivan,** resigned.

Albert E. Bickell has been appointed assistant district sales manager of General Refractories Co.'s Pittsburgh, Pa., office. Mr. Bickell was born in Philadelphia, received his degree in engineering from Penn State in 1936, and was assigned to General Refractories' Buffalo sales office in February, 1937. In January of 1947, he was transferred to the Philadelphia office. **George L. Peck,** who has been with the General Refractories Pittsburgh sales office since 1948, will replace Mr. Bickell in the Philadelphia office.

John N. Marshall, chairman of the board of directors of the Granite City Steel Co., Granite City, Ill., was reelected to that office and also elected president. As president, Marshall succeeds **N. B. Randolph** who retired because of ill health.

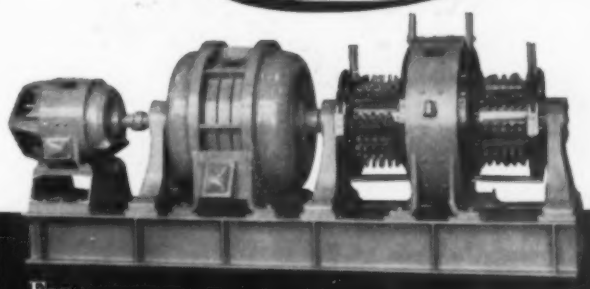
A. S. Johnson was named general manager of the National Carbon division of Union Carbide and Carbon Corp., New York, N. Y.

William H. Lyon, master mechanic of the maintenance department, was appointed supervisor of engineering and maintenance at the American Steel & Wire Co.'s Trenton, N. J., works.

Joseph A. Walsh, master mechanic of the maintenance department, has been appointed supervisor of

(*Please turn to page 152*)

Motor Generators by COLUMBIA



For
Electroplating — Anodizing
Electrocleaning — Electropolishing

There's a Columbia M-G Set available for your needs, whether you have a small plating bath or a large continuous strip plating line. Capacities up to 20,000 Amperes; 6 Volts and up. Dependable, performance proved, for many years. Your inquiries solicited.

Write today for Catalog IS-700

COLUMBIA ELECTRIC MFG. CO.
4543 HAMILTON AVENUE CLEVELAND 14, OHIO

For **SAFETY** *in marking all kinds of Metal*

Use **SAFETY "HEVI-BEVL" LETTERS and FIGURES**

The most economical all purpose grade of Safety Letters and Figures. Will give outstanding service on almost any marking job. All sizes —1/32" to 1" characters from stock. Mecco Safety Steel for No Spalling and No Mushrooming.

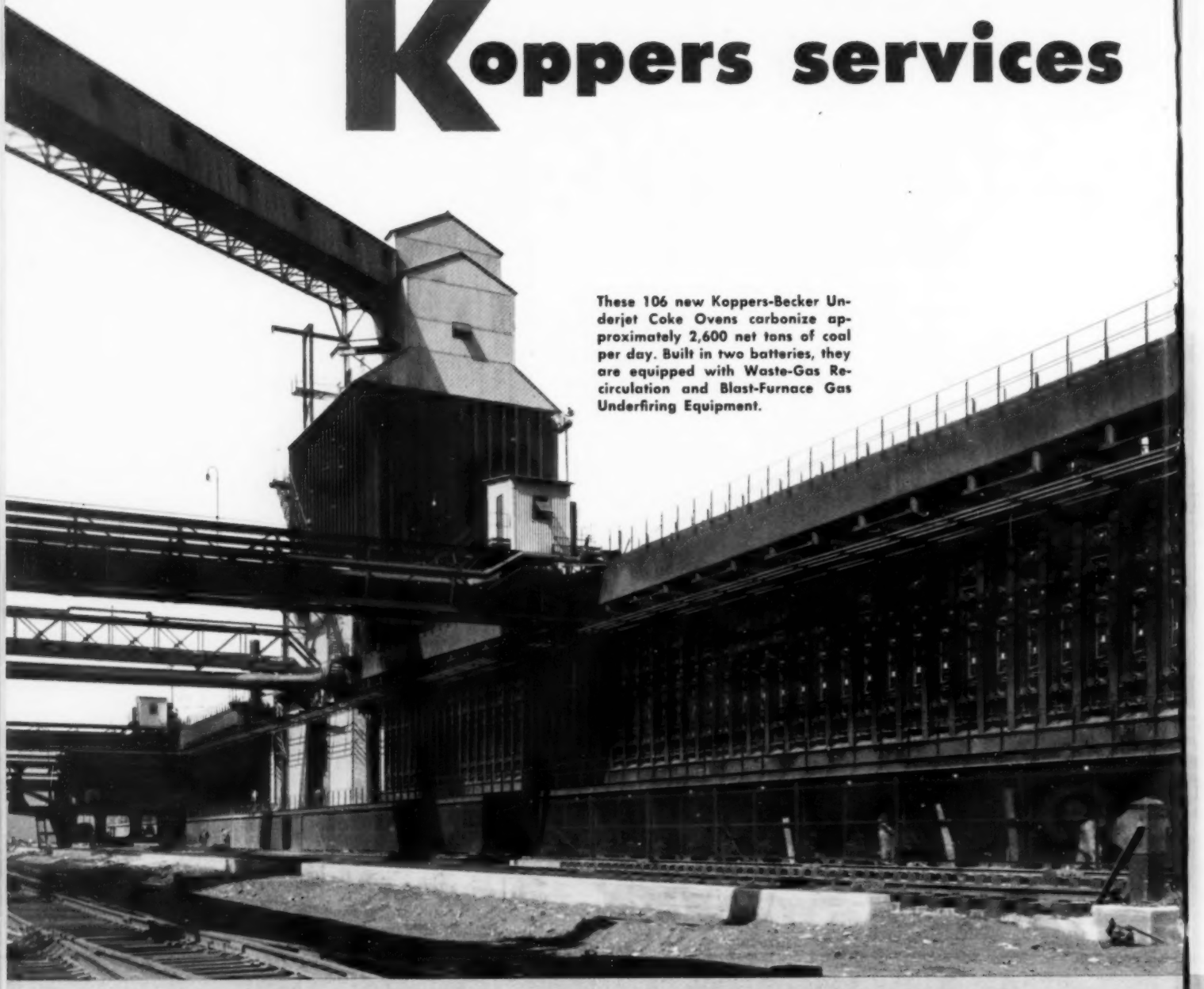
Write for Bulletin LF-50.

- No Spall
- No Mushroom
- More Service
- Thumb Side Marks for easy identification

M. E. CUNNINGHAM CO.
SAFETY STEEL STAMPS

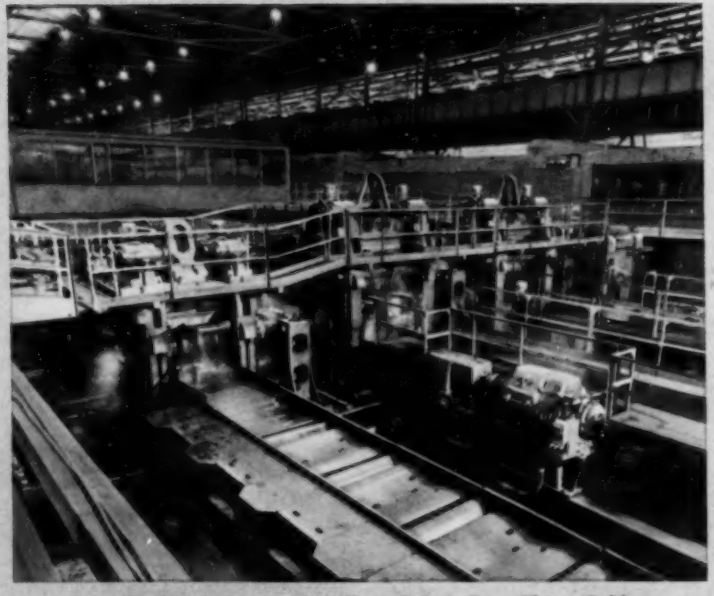
105 East Carson Street • Pittsburgh 19, Pa.

Koppers services



These 106 new Koppers-Becker Underjet Coke Ovens carbonize approximately 2,600 net tons of coal per day. Built in two batteries, they are equipped with Waste-Gas Recirculation and Blast-Furnace Gas Underfiring Equipment.

This plant was constructed by Koppers for the recovery of ammonium sulphate, tar, light oil and pure benzol products from the carbonizing of 1,050 tons of coal daily.



Freyn-Designed Structural Mill and Traveling Tilting Tables.

for the steel industry...

KOPPERS Company and its subsidiary, Freyn Engineering Company, offer comprehensive engineering and construction services to all branches of the iron and steel industry.

Freyn Engineering Company: Specialists in the design and construction of blast furnaces, open-hearth furnaces and sintering plants . . . in the engineering of mills, power plants and other steel plant facilities.

Koppers Engineering and Construction Division: Specialists in the design and construction of coke oven plants, auxiliaries and coal chemicals plants.

The installations pictured here give some indication of the scope of Koppers Metallurgical Engineering and Construction Services. Our Engineers and Management welcome the opportunity to consult with you.

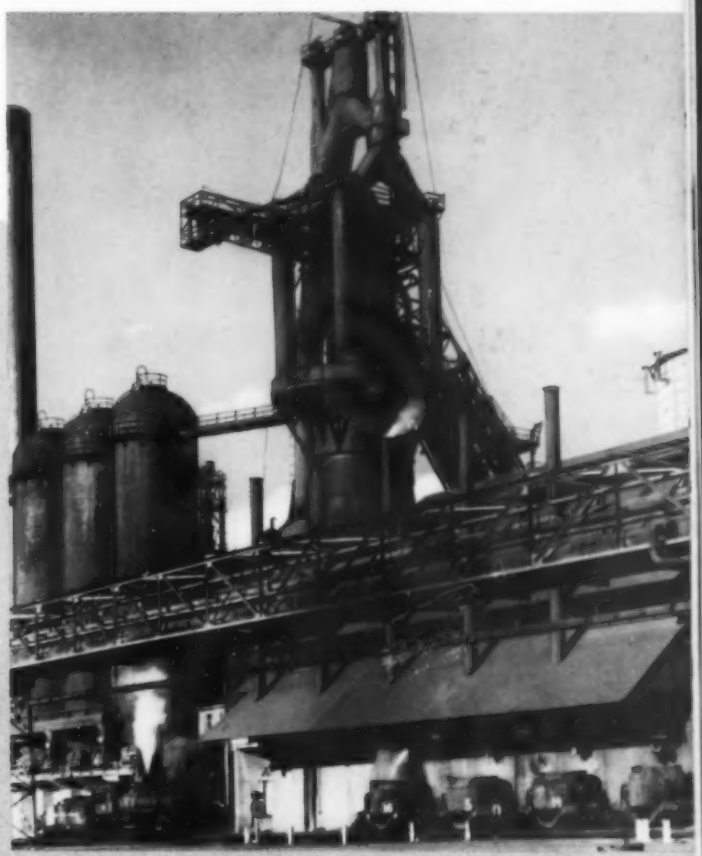
KOPPERS COMPANY, INC.

ENGINEERING AND CONSTRUCTION DIVISION

Pittsburgh 19, Pa.

KOPPERS

Freyn-Designed and Constructed Open-Hearth Furnaces.



Typical Freyn-Design Blast Furnace.

for **HIGH SPEED PRODUCTION**

. . . . . modern Steel Mills consider Bowser Lubricating and Coolant Systems a *MUST!*

For more than 35 years Bowser lubricating engineers have matched every improvement in anti-friction bearing design with efficient, continuous oil reclamation and coolant systems.

For the best insurance against bearing failure—whenever new steel mill equipment is required — write . . .

BOWSER ESTABLISHED 1885

BOWSER, INC.
1314 Creighton Avenue,
Fort Wayne 2, Indiana.

LIQUID CONTROL SPECIALISTS SINCE 1885

Browning Mill Type Cranes are built in accordance with A. I. S. E. specifications. They incorporate the types of motors and controls on which your mill or industry has standardized. This flexibility adapts your VRB crane *perfectly* to your needs. Only the finest materials are employed. Browning heavy duty cranes meet the most rigid demands and satisfy the most critical users. Our design, placing plenty of strength wherever needed, is the outgrowth of 48 years' experience in the crane industry.

"Built as you yourself would build them"

Write for our Bulletin "S".

VRB

VICTOR R. BROWNING & COMPANY, Inc.
BOX 309, WILLOUGHBY (CLEVELAND), OHIO
Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

(*Continued from page 149*)

engineering and maintenance at the American Steel & Wire Co. New Haven, Conn., works.

Charles J. Petry was named to the post of assistant division superintendent steel works, of the American Steel & Wire Co.'s South works at Worcester, Mass. Mr. Petry comes from Cleveland, Ohio, where he has held the position of division metallurgist for the wire company.

Dr. Kent R. Van Horn will become associate director of research for Aluminum Co. of America, effective August 1, 1950. Dr. Van Horn is at present an assistant director of research for the company, and has been in charge of Alcoa's branch laboratories at Cleveland, Ohio, since 1945. He will be transferred to New Kensington, Pa., to assume his new duties.

Henry M. Heyn, of Surface Combustion Corp. was elected president of the Industrial Furnace Manufacturers Association for the current year.

William Deans, chief engineer of the I-T-E Circuit Breaker Co., Philadelphia, Pa., has been elected vice president in charge of engineering. He will be responsible

WILLIAM DEANS

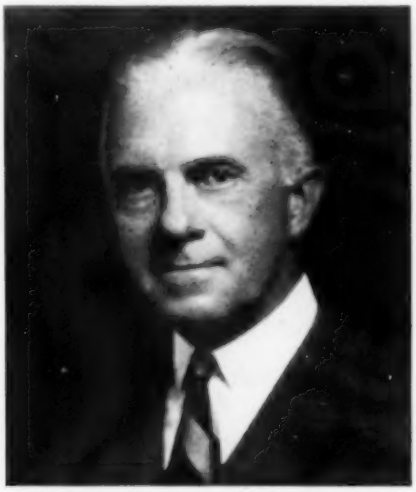
for organization of the company's major engineering policies and coordination of all engineering matters

GUS E. HEBERLEIN

among the company's various divisions and subsidiaries. **Gus E. Heberlein,** who has been chief engineer of I-T-E's subsidiary, Railway & Industrial Engineering

Co., Greensburg, Pa., has been appointed manager of the switchgear division of the parent company. Mr. Heberlein will have charge of sales, engineering, manufacturing, and associated services for large air circuit breakers and switchgear.

G. G. Coolidge has been appointed executive assistant to the president of Harbison-Walker Refractories Co., Pittsburgh, Pa., in a move awaited since he



G. G. COOLIDGE

relinquished his title as vice president in charge of sales last month due to company retirement policies. Mr. Coolidge had been a vice president of the company since 1933 and continues to retain his directorship which he attained at the same time.

A. H. Toronski was appointed chief engineer of carbon and graphite products for Speer Carbon Co. Previously Mr. Toronski was assistant chief plant engineer.

Elmer F. Twyman was named vice president in charge of the Philadelphia, Pa., division of Yale and Towne Manufacturing Co., to succeed **James C. Morgan** who has retired under the company's pension plan. Mr. Twyman for the past 15 years has been general manager of the Automatic Transporation Co. division of Yale and Towne, in Chicago, Ill.

Howard M. Graff has been named to the post of assistant general superintendent of Inland Steel Co.'s iron ore mines.

John W. Unroe has been appointed general manager of the Steubenville works, Wheeling Steel Corp., succeeding the late **William H. Warren.** Mr. Unroe had been assistant to Mr. Warren.

Obituaries

Charles Hart, 81, former president of the Inland Steel Co., Chicago, Ill., and the Delaware Steel Co. of Chester, Pa., died May 23 after a long illness. He lived in Media, Pa. Mr. Hart began his long career in the steel industry with the Carnegie Steel Co., Pittsburgh, Pa. Transferring to the Republic Iron and Steel Co., Youngstown, Ohio, he was made a vice president of that company in 1907. He retired ten years ago.

David S. Smith, 60, general superintendent of the Niles Rolling Mill, Niles, Ohio, died in Trumbull Memorial Hospital, at 11:55 p.m., Tuesday, April 11.

Dravo Crane Cab Coolers are simple to install; all parts are readily accessible for servicing.

DRAVO CRANE CAB COOLERS
ASSURE OPERATOR COMFORT

Operators of hot-metal cranes are more alert and efficient when you protect them from fatigue and discomfort by air conditioning the cabs with Dravo Crane Cab Coolers.

Completely self-contained, and requiring only an electrical connection, the Dravo Crane Cab Cooler provides complete air conditioning:

Cooling	Continuous Ventilation
Fume and Odor Removal	Dehumidifying
Dust Filtering	Winter Heating

DRAVO CORPORATION
PITTSBURGH • PHILADELPHIA • CLEVELAND • NEW YORK
CHICAGO • DETROIT • ATLANTA • BOSTON
Sales Representatives in Principal Cities

DRAVO

QUICK DELIVERY
that will SATISFY
unpredictable needs of . . . .

BRONZE and COPPER CASTINGS
COOLING PLATES
HOT BLAST VALVES and SEATS
WELDING BELLS
COOLERS • TUYERES
LONG WEARING RESISTANT ELECTRODES

FALCON QUALITY
based on 60 Continuous Years of "Know How"

Illustrated is an installation of Falcon-produced Kinney Refractory-Lined Tuyere Cooler, U. S. Pat. App. Serial 530153, and Holzworth "Split Nose" Tuyere, U. S. Pat. 1,789,870.

Wide Double Contact Surfaces — Spring Tension Locking of Links

Expansion and contraction of metals during **Off** and **On** periods compress links. This fluctuation causes loose contacts and oxidation in other fuses, which finally result in excessive heating and unnecessary blows. WARE HI-LAG construction keeps contacts permanently tight, thus insuring low resistance and longer fuse life.

In addition to WARE Hi-Lag Renewable Fuses, we make:
WB Renewable Fuses without special time lag;
WARE Non-Renewable Fuses, rugged one time construction;
WARE Trolley Tap Fuses designed specially for coal mines.

Approved by Underwriters Lab. — Write for Circular

WARE FUSE CORPORATION
4460 W. LAKE ST. CHICAGO 24, ILL.

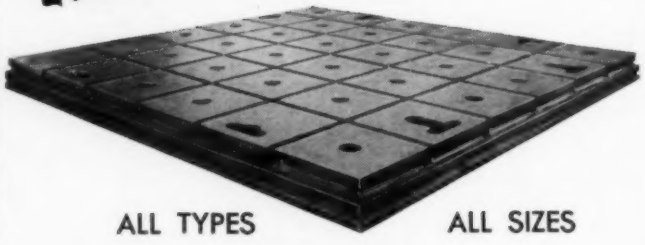
Joseph E. Holveck, hydraulic engineer, Worthington Pump and Machinery Corp., died May 20 at Mountainside Hospital, Montclair, N. J. Mr. Holveck was born

JOSEPH E. HOLVECK

in Wilmington, Del., July 14, 1883. From 1901 to 1935 he was connected with Aldrich Pump Co. at Allentown and Pittsburgh, Pa., eventually becoming a vice president of that company. He joined Worthington in 1935 as a sales engineer in the corporation's Pittsburgh district office and was sent to the general sales offices at Harrison, N. J. in 1943.

Albert R. Zelt, 50, assistant to the vice president in charge of mill operations of the Carnegie-Illinois Steel Corp., died recently in Youngstown, Ohio.

Hyde Park FLOOR PLATES



ALL TYPES ALL SIZES

Floor Plates, Surface Plates and Layout Tables made to specifications.

CHILLED and ALLOY IRON ROLLS
ROLLING MILL MACHINERY
GRAY IRON CASTINGS
(Up to 80,000 pounds)

Inquiries invited.

HYDE PARK FOUNDRY & MACHINE CO.
HYDE PARK, PA. (PITTSBURGH DISTRICT)

Here's How to Erase Smoke Troubles

VIOLATION OF SMOKE ORDINANCE

LOSS OF FUEL ECONOMY

BAD COMMUNITY RELATIONS

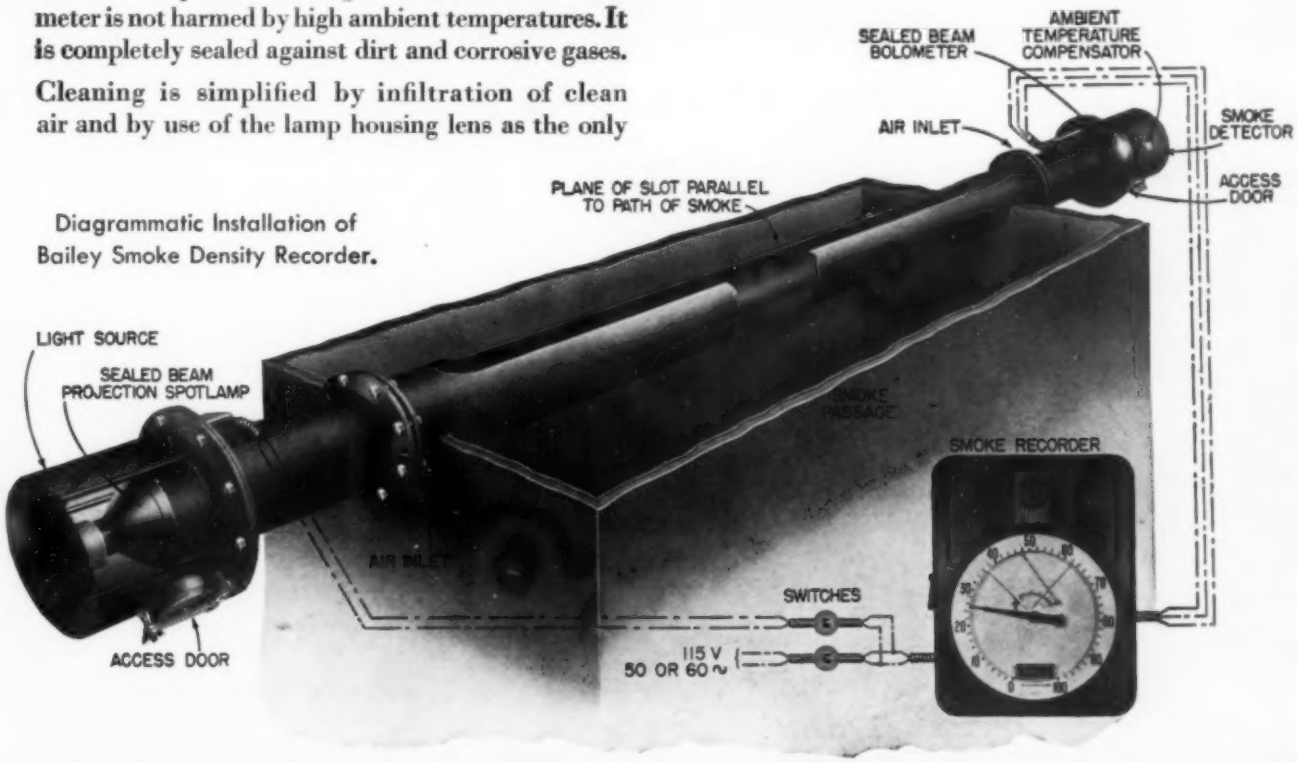
★ One of your first steps in erasing these troubles which result from excessive smoke, should be the installation of a Bailey Smoke Density Recorder. This 24-hour recorder is not an ordinary photo-cell instrument. Instead it detects smoke density by a Bolometer which is simply a sturdy tungsten filament and a parabolic mirror, mounted in a standard sealed beam automobile head lamp housing.

In using this simple, unique smoke detector, you do not have to provide cooling devices since the Bolometer is not harmed by high ambient temperatures. It is completely sealed against dirt and corrosive gases.

Cleaning is simplified by infiltration of clean air and by use of the lamp housing lens as the only window between the Bolometer and the gas passage.

It's easy to secure and maintain alignment of the sealed beam light source with the Bolometer since they are mounted at opposite ends of a slotted pipe which extends across the smoke passage.

For complete information on how you can profitably use this unique instrument to erase your smoke troubles, ask for Bulletin 211, "Bailey Smoke Density Recorder".



Diagrammatic Installation of Bailey Smoke Density Recorder.

G-29

BAILEY METER COMPANY

1047 IVANHOE ROAD, CLEVELAND 10, OHIO • BRANCH OFFICES IN PRINCIPAL CITIES

BAILEY METER COMPANY LIMITED, MONTREAL, CANADA

Let Bailey Smoke Density Recorders Watch Your Stacks

15-TON SCARFING BUILDING CRANE

BUILT BY MORGAN Engineering

Illustrated is a Morgan 15-ton, 3-motor, 40′-0″ Span Half Gantry Type Scarfing Building Crane. Hoist is actuated through a worm reduction unit for operating a counterweighted hoist rack connected to two lifting magnets, for handling slabs.

THE MORGAN ENGINEERING CO.

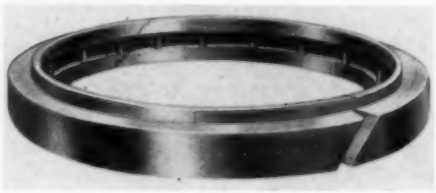
ALLIANCE, OHIO PITTSBURGH—1420 OLIVER BUILDING

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

Equipment News...

DEVELOP IMPROVED METHOD OF REPLACING CRACKED OR WORN METAL TIRES

▲ An improved method of replacing cracked or worn metal tires on kilns, coolers and driers has been developed by Stroh Process Steel Co. This tested and proved method of tire replacement, which reduces production losses due to down time, is based on the use of a diagonally cored split tire. By means of interlocking machined mating surfaces in the rim, this tire can be positioned in the field without tearing out a section of a shell or disturbing the shell's existing alignment. After positioning, the split is welded to make a full, solid ring, which has no machined bolt-held mating surfaces to loosen up under load and heat. The weld metal at the splits does not "hump up" and the tire rolls smoothly over the welded joint.



The only machine work required on the Stroh ring, over and above that of a solid ring, is the planing of the interlocking machined mating surfaces of the rim. This eliminates much expensive machining to close tolerances, necessary on conventional four segment split tires. Easier installation of the diagonally cored design is achieved, since a kiln operator can normally handle a half ring with existing equipment, while in many cases a full ring requires the use of special cranes and outside riggers.

The shell is supported near the damaged tire with a cradle of oak planks, in order to back off the trunnion rollers. The old tire is burned off and the ring halves are positioned with one split at the top of the shell, which is centered with spacer blocks. After the tire is bolted to the shell, the top weld is made. In making this weld, the recommended procedure is to preheat the joint and peen the weld metal as it is laid in. The rollers are then repositioned, the load taken off the cradle, and the shell turned to bring the second split to the top. Upon completion of the welding of the second split, bolts are removed and the tire is riveted up. With rollers repositioned and cradle removed, the kiln is ready for operation.

These tires are machined from .35-.45 carbon fully annealed acid open hearth steel castings, ASTM Specification A 27-46T Grade N_2. With the carbon on the high side, this material will show about 170-180 Brinell on the unworked, machined surface of the face, and will work-harden to about 190-200 Brinell. Without excessive sidewise flow of the material, a safe loading of about 10,000 lb per inch of face can be attained. This value, however, varies with the ratio of the diameters of the tire and roller.

END HEATING FURNACES FOR SUCKER RODS

▲ Outstanding indeed for their productive capacity and compact construction are these four high speed end heating furnaces recently built by Surface Combustion Corp. for a leading manufacturer of oil field equipment.

These four furnaces will be used for heating the ends of steel oil well sucker rods—⅝ to 1 in. in diameter—for upsetting the ends. They will operate on natural gas and have a designed capacity of 180 one-inch diameter bars each per hour. Seven bars are in process in the furnace at any given time.

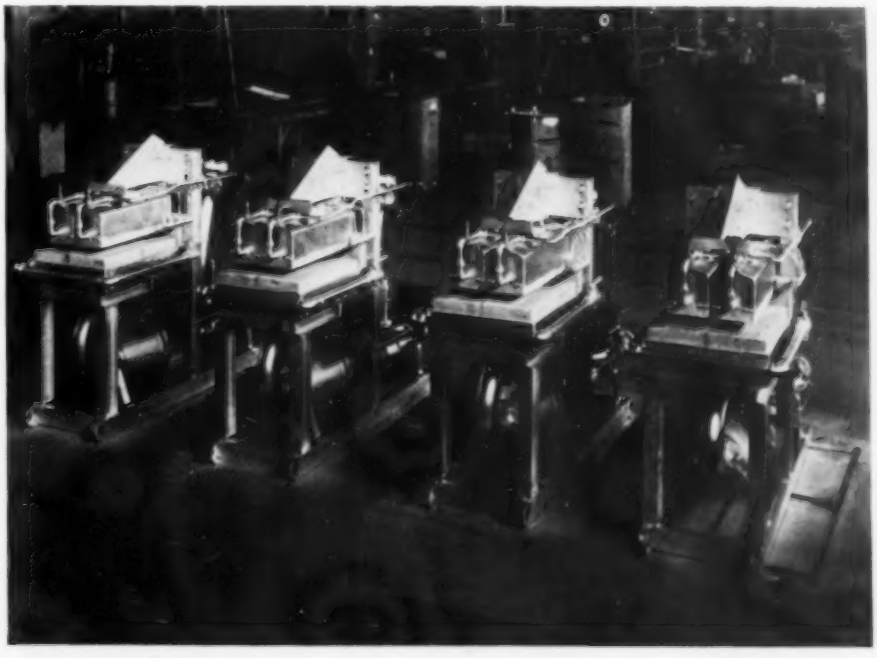
To meet the production line requirements, the furnaces were designed with a maximum width of 21 in. Each furnace has a heating zone 15 in. wide and a 1,210,000 Btu per hour heat input.

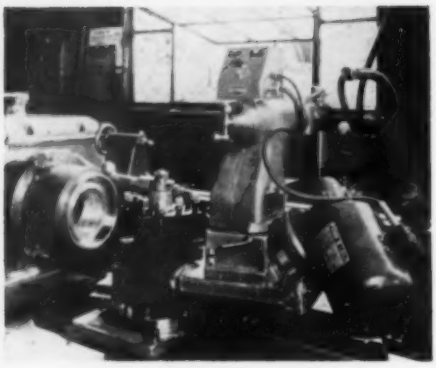
ELECTRONIC DUPLICATOR ATTACHMENT FOR LATHES

▲ Extensive research during the past few years by Raytheon Manufacturing Co., has resulted in the development of an electronically-controlled duplicator attachment for machine tools.

The advantages of this duplicator lie in the infinite simplicity of operation and its ability to provide a smooth control over very slight changes in contour — combined with the ability to make abrupt changes in contour without overshooting.

These high-speed end heating furnaces operate on natural gas and have a capacity of 180 one-inch diameter bars each per hour.





Successful installations of this attachment have been made on roll turning lathes.

Voss Engineering Co. is distributor of this device for lathes and vertical boring machines. Voss has made successful installations on various types of engine lathes, turret lathes, roll turning lathes, and vertical boring machines for reproduction of cams, turning of molds, complicated contours of rolls, axles and other irregularly shaped parts.

TUBE STRAIGHTENER SOLD TO ITALIAN MILL

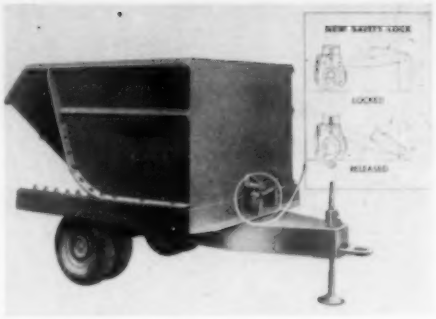
▲ Sutton Engineering Co. has recently received an order from Italy for one No. 4 KTC tube straightener having a capacity of 8.66 in. to 18 in. outside diameter steel tubes. This straightener is of the most modern type being equipped with power operated screw downs and the Sutton patented method of automatically adjusting roll inclination while setting for stock size.

SELF-DUMP TRAILER HAS SAFETY LOCK

▲ A new "Phil-Dump" trailer for heavy duty moving and dumping of all types of industrial materials has been developed by Phillips Mine and Mill Supply Co. This new dump trailer has a three cubic yard self-dumping hopper, with a new safety lock which provides positive locking and prevents accidental dumping of load.

Made from heavy gauge steel, this trailer has a delicately balanced hopper which automatically dumps when the safety lock is released. After the load has been dumped, the new Phillips safety lock is designed to automatically lock the hopper in place when it returns to loading position.

Other features of the Model DP-3B trailer are: (1) jack stand for accurate leveling, (2) structural reinforcements with rolled edges to prevent injury to personnel and possible tearing of load, (3) sturdy steel hopper and frame which ride on dual pneumatic tires, mounted entirely underneath the frame to provide a minimum overall width. Extremely simple in operation with a minimum of moving parts, this "Phil-Dump" trailer is easily pulled and maneuvered by an industrial tractor.



This new trailer has a delicately balanced hopper which automatically dumps when safety lock is released.

The Phillips safety lock now is being supplied on the complete line of "Phil-Dump" automatic dumping equipment, with capacities ranging from ½ cu yd to 3 cu yd.

INSULATION TESTERS USEFUL IN FIELD TESTS

▲ The higher and wider ranges now available in megger insulation testers are extremely useful in several kinds of field tests, particularly in testing circuit breaker bushings, and in making time-resistance (dielectric absorption) tests on apparatus which has relatively high 10-minute insulation resistance values.

The extremely wide range of the new instruments is accomplished by two overlapping scales which results in an 8½ in. scale length, as against 3½ in. in the old instruments. A simple switch selects between one scale or the other without the use of a multiplier or divider.

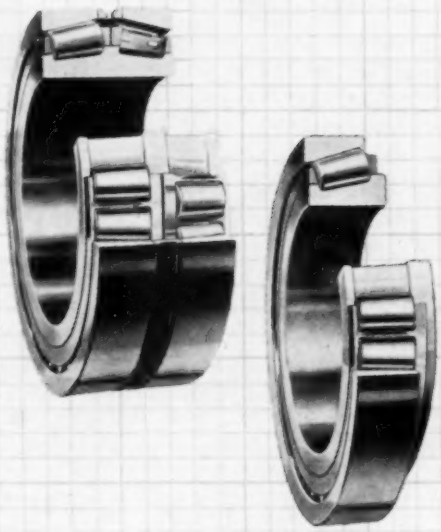
This new high range megger instrument gives the maintenance engineer a simple, relatively inexpensive tool for detecting the deterioration in bushings. In the cases of some generators, transformers and cables with relat vely high 1-minute insulation resistance values, which may increase with time during time-resistance tests, the instrument range should be high enough to permit this increase of resistance with time to be accurately observed.

These are only a few typical cases where these new higher and wider

ELLIOTT CO. DEMONSTRATES MILL MOTOR

A new Elliott-Crocker-Wheeler mill motor was put through its paces for steel mill executives and engineers at the Elliott Co., Jeannette, Pa. plant, April 18 and 19. The motor, conforming to current AISE standards in every respect, provides more power and torque in the same space. It was demonstrated to over 100 guests in a test set-up which simulated extremely severe operating conditions. Commutation was observed while the motor was reversed at overloads as high as 300 per cent current and no evidence of sparking could be detected.

TORRINGTON BEARINGS on Mesta reels help maintain even tension at high speeds



Mesta Machine Company mounts the shaft of its high-speed tension reel on Torrington Tapered and Straight Roller Bearings to help maintain even tension on strip steel at high rolling speeds.

Torrington Bearings hold the reel drum in proper alignment radially and axially, to prevent wobble or end play that would cause coning or uneven coils. Friction drag and wear is minimized to assure uniform tension and sustained concentricity. Tremendous loads are safely carried by these heavy-duty bearings.

To reduce wear and secure long service life with minimum maintenance, be sure to specify Torrington Bearings for your heavy-duty equipment. Our engineers will be glad to work with you on any friction problem.

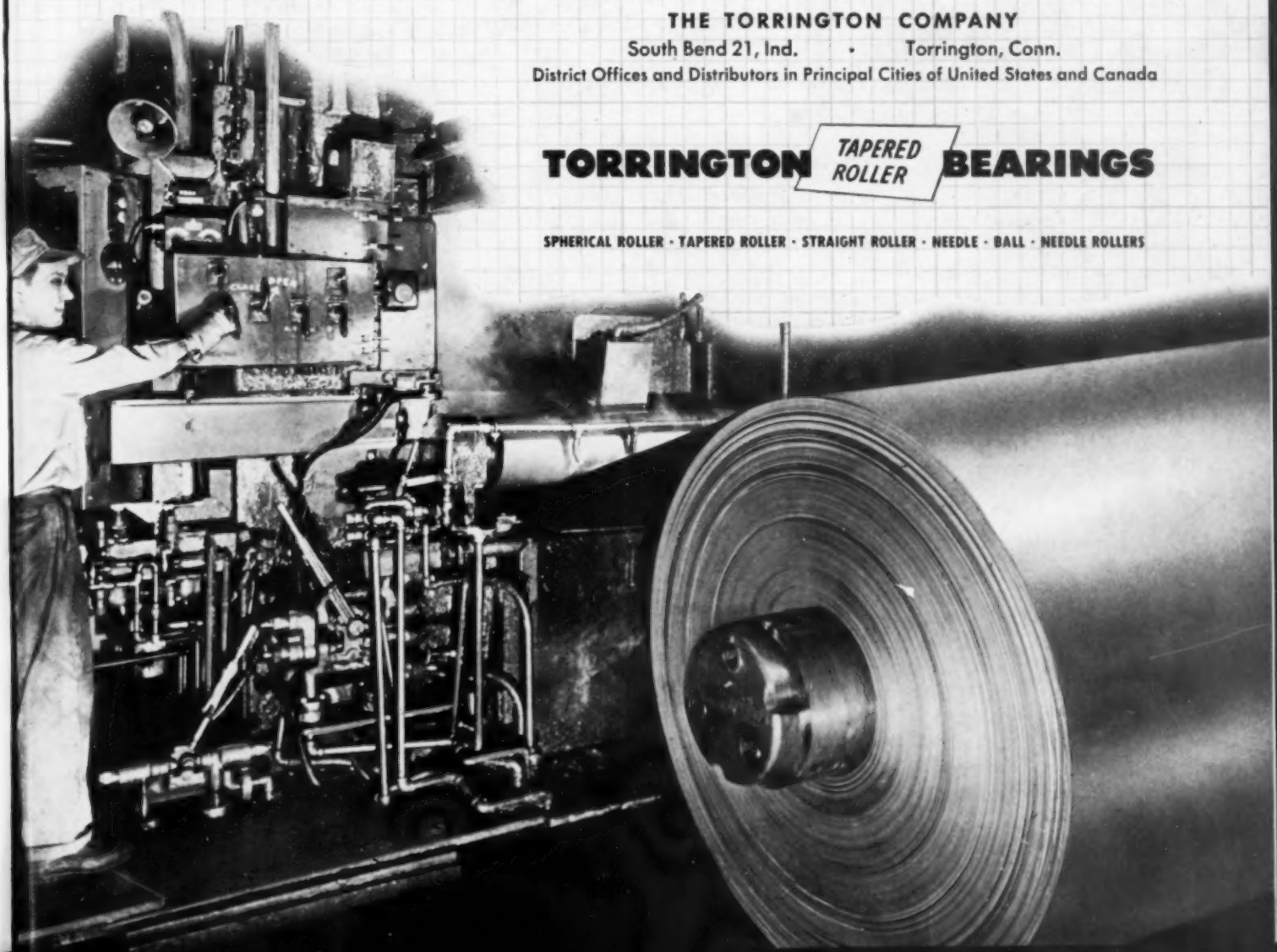
THE TORRINGTON COMPANY

South Bend 21, Ind. • Torrington, Conn.

District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON TAPERED ROLLER **BEARINGS**

SPHERICAL ROLLER · TAPERED ROLLER · STRAIGHT ROLLER · NEEDLE · BALL · NEEDLE ROLLERS



The maintenance engineer has an excellent tool for detecting deterioration in bushings.

ranges offer decided advantages. The increased usefulness of these instruments will be reflected in applications in the field of preventive maintenance and production testing. Manufacturer is the James G. Biddle Co.

ELECTRICAL EQUIPMENT SOLD TO ITALY UNDER ECA

▲ Electrical equipment totaling more than $1,000,000 is being supplied to the Italian steel industry by Westinghouse Electric International Co., under an ECA program to modernize the industry and reduce import requirements. Four companies are involved in the current Westinghouse orders.

Two subsidiaries of the Lombardi Falck Steel Corp., Milan, will receive apparatus for new cold strip mills and other installations. Cantieri Metallurgici Italiani, located at Castellamare, near Naples, has ordered a 1750-hp main drive motor, two 600-hp reel motors and a 1400-kw main motor-generator set. This $405,000 order is for a new 46-in. cold strip mill.

Officine Metallurgiche Broggi, also a Falck subsidiary, which is installing a four-high cold strip mill, a cluster mill and a cleaning line, will receive motors ranging from 50 to 225 hp as well as motor-generator sets. Ilssa-Viola, another steel concern, has ordered a 2000-kw motor-generator set and control equipment, valued at $147,000 for a blooming mill.

The Fiat automobile concern is enlarging its steel fabricating facilities in the vicinity of Turin, to supply its plants with products formerly purchased from steel companies. Besides 80-in. and 16-in. cold strip mills, the company is installing a slitting mill, shearing line and pickling line, for which Westinghouse is supplying $388,000 worth of apparatus, including motors in capacities up to 400-horsepower and motor-generator sets.

Deliveries on all orders are scheduled for completion by December.

DEVELOP NEW GRAPHITE FOR INGOT MOLD WASH

▲ United States Graphite Co. has announced the development of "Mex," a new ingot mold wash that combines all the best features of an ideal coating with none of the undesirable characteristics. The wash contains Mexican graphite and has several outstanding advantages over ordinary mold coatings. It's safe, easy to use, gives off no fumes, and is not harmful to skin or clothing. This new product also contains a hydrocarbon for "gas kick" in repelling metal splash. Stripping is made easier through the non-wetting, lubricating action of this graphite. It will stay in suspension for hours between heats. In actual operations, costs are under ¾-cent per ingot ton to use.

As an added customer service, the supplier will furnish spray test equipment, at no charge, with orders of five or more tons in order that users of the new wash may actually test for themselves the many advantages of this product.

Fumeless and nonharming to skin or clothing are some of the advantages of this ingot mold wash.

Book Reviews . . .

▲ Kent's "Mechanical Engineers' Handbook," for over fifty years the classic in its field, was published in a new, twelfth edition on May 29, by John Wiley & Sons.

Comprising two separate, inclusive volumes, each written by a staff of experts, the new "Kent" accurately reflects the developments in mechanical engineering that have been made since the eleventh edition was published in 1936. Volume I — "Design and Production" — has been edited by Colin Carmichael, editor of Machine Design; Volume II — "Power" — was prepared under the supervision of J. K. Salisbury, Division Engineer, Thermal Power Systems Division of the General Electric Company. Approximately 3000 pages in length, the handbook is priced at $8.50 per volume.

▲ NEMA has recently published the following standards, and copies are available for immediate distribution: NEMA STANDARDS FOR MINING AND INDUSTRIAL ELECTRIC LOCOMOTIVES, PUBLICATION NO. MI1-1950. Electric locomotives up to and including 35 tons rated weight, which are equipped with flanged wheels for operation on rails, which obtain their power from a trolley wire, third rail or storage battery, and which are not designed for regular operation on railroads or railways, nor equipped with Interstate Commerce Commission (ICC) safety features, are covered by this publication. Standards for motors, control, construction and accessories as related to mining and industrial electric locomotives are given in detail. ($1.50 per copy).

▲ NEMA STANDARDS FOR GEARED STEAM TURBINE SYNCHRONOUS GENERATOR UNITS (500-1500 KW, INCLUSIVE), PUBLICATION NO. TU2-1950. Publication No. TU2-1950 was prepared to serve as a counterpart to existing NEMA Standards for direct-connected turbine generators and to take its place in the broad series of NEMA Standards Publications dealing with steam turbines, turbine-generator sets, helical reduction gears for use with steam turbines and speed governing and pressure control of steam turbine-generator units. ($0.80 per copy).

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such as:

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- PICKLING TANKS
  Plain or Rubber Lined
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BRANDT offers 240,000 sq. ft. of facilities for *real help* in solving your engineering and production problems. Help that *saves time* and *money* too! Completely equipped for fabricating *any type* of metal. Precision metal craftsmen since 1890, accustomed to handling a variety of specialized projects in *a wide range of sizes.*

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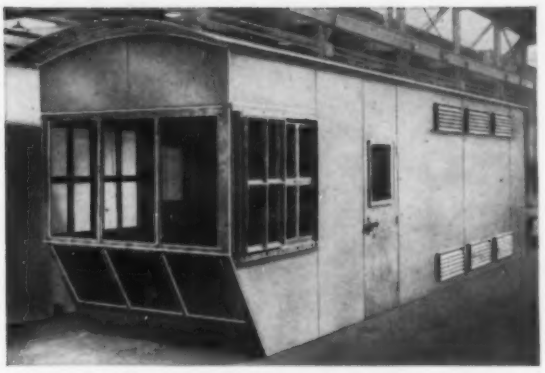
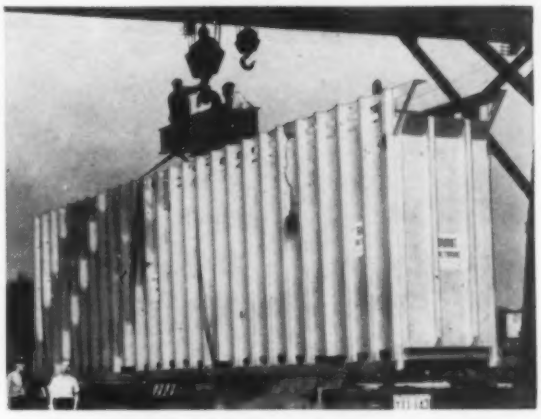


STEEL CONTROL AND REGISTER HOUSE FOR STEEL MILL



30 TON ELECTROLYTIC PLATING TANK BUILT FOR A STEEL MILL CUSTOMER

STEEL MILL ROLL TABLES

BRANDT BALTIMORE *measures up!*

TO EXACTING STEEL MILL EQUIPMENT SPECIFICATIONS

Brandt facilities are all under one roof, strategically located near steel mills, in the midst of major rail, water and highway transportation systems.

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STRIP COILS *go--lift--turn*

at Carnegie-Illinois Steel Corp. (Gary Sheet and Tin Mill)

This is one of two Link-Belt Lift and Turn Transfers which are part of the hot strip coil handling system at the Gary Sheet and Tin Mill. The illustration shows the unit about to deposit a coil of hot strip on the conveyor extending to the right. As the Lift and Turn unit is automatically lowered to deposit the coil, the vacant pocket (in the foreground) will be in position for the next coil to advance, be picked up, turned 90 degrees and lowered in the same manner as the preceding coil.

The system not only handles coils mechanically—it handles them safely, gently, carefully without rolling or scuffing, at every transfer point and throughout the length of the conveyor system, eliminating edge damage.

Link-Belt Engineers will be pleased to discuss your conveying and power transmission problems without obligation to you.

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NEW CASTLE, PENNA.

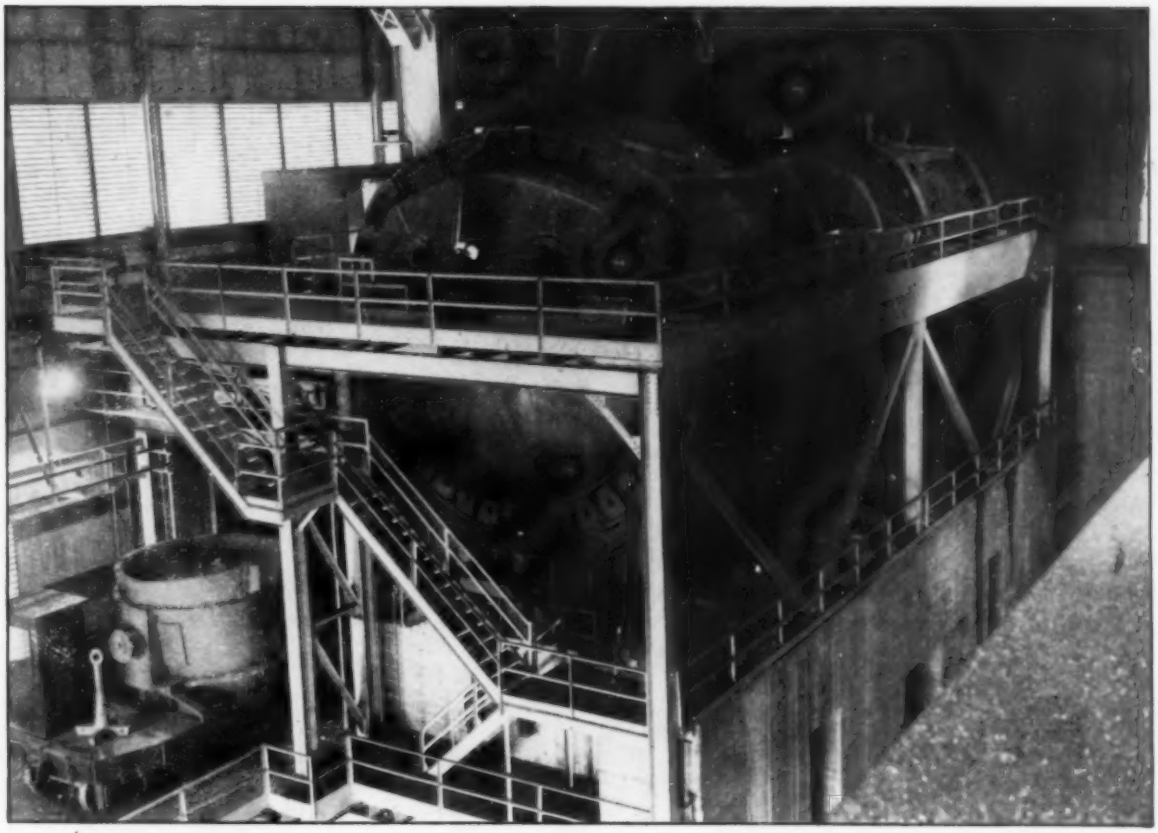
Designers, Fabricators and Erectors of

HOT METAL MIXERS

FOR

BESSEMER AND OPEN HEARTH PLANTS

25 — 2000 TON CAPACITY



2 — 800 TON MIXER INSTALLED AT CARNEGIE-ILLINOIS' HOMESTEAD NEW OPEN HEARTH PLANT

Installation of Mixers

in the following steel plants

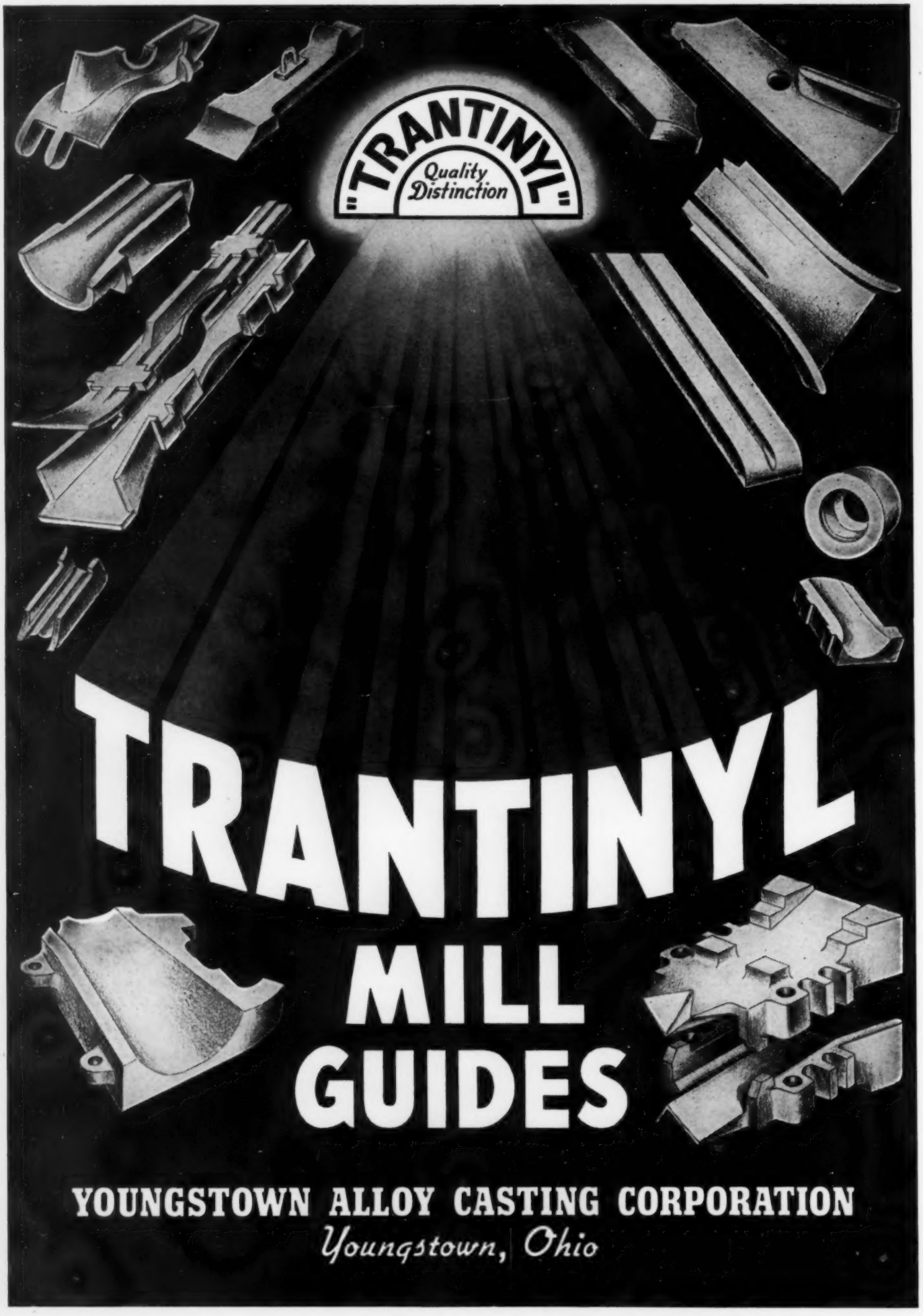
Wheeling Steel Corporation
Carnegie-Illinois Steel Corporation
National Tube Company
Tata Iron and Steel Company, India
Jones and Laughlin Steel Corporation
Amtorg Trading Corporation, Russia
Weirton Steel Company
Tennessee Coal, Iron & Railroad Company
Bethlehem Steel Company
Algoma Steel Company, Canada
Youngstown Sheet and Tube Company
Republic Steel Corporation
Siderurgica del Mediterraneo, Spain
Inland Steel Company
Monterrey Steel Company, Mexico
Cia Acos Especiais Itabira, Brazil
Great Lakes Steel Corporation
National Steel, Brazil

25-TON BESSEMER CONVERTER

Auxiliary Equipment

for Open Hearth and Bessemer plants

Converters
Tilting Open Hearth Furnaces
Ladles
Ladle Stands
Ladle Transfer Cars
Cupolas
Slag Cars
Dragouts
Slag Pots
Jib Cranes
Jack Cars
Bottom Oven Cars
Bottom Ovens
Post Ladle Cranes
Ingot Cars
Scrap Buckets
Charging Box Cars
Blast Furnaces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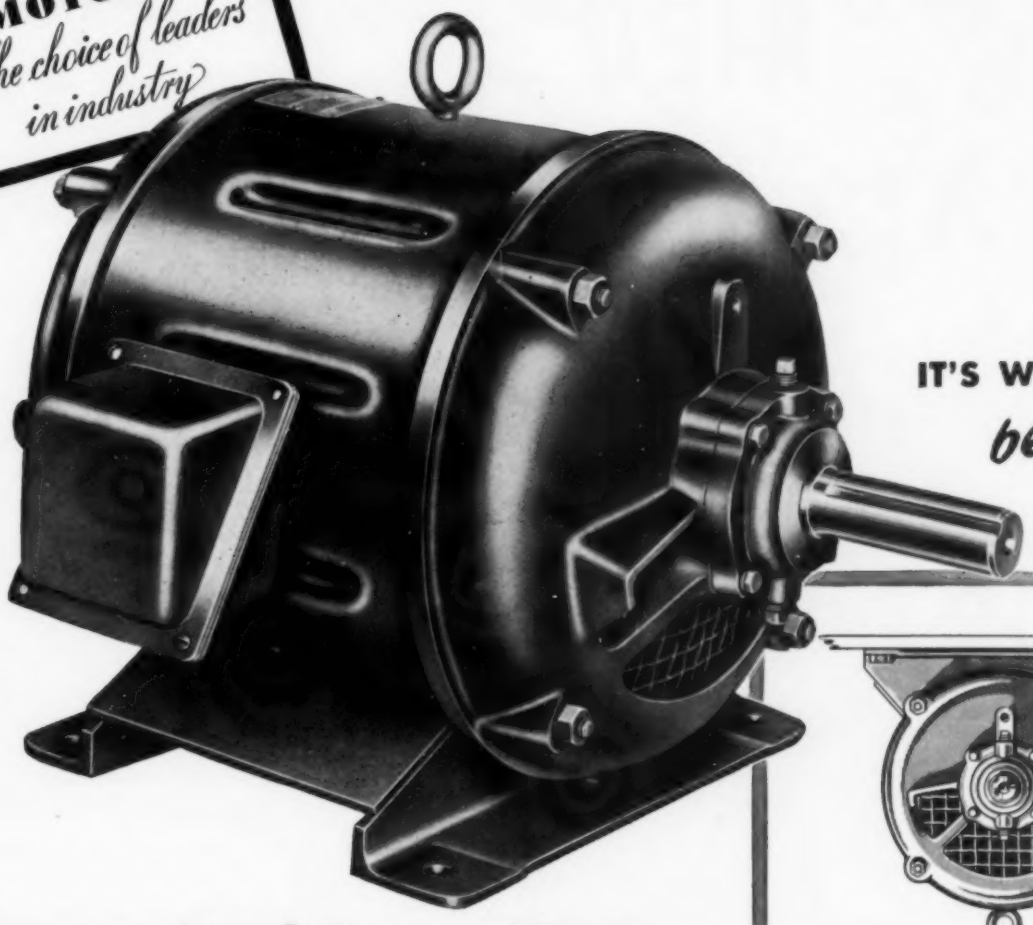

IT'S WAGNER *because:*

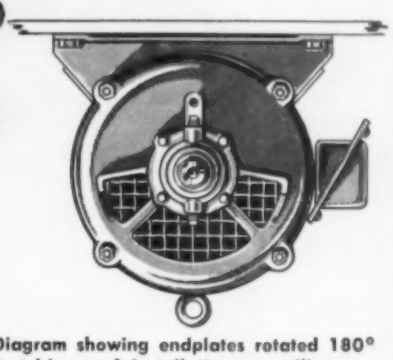

Diagram showing endplates rotated 180° for drip-proof installation on ceiling.

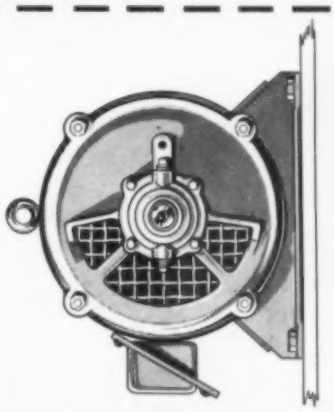

Diagram showing 90° rotation of endplates for drip-proof horizontal mounted sidewall installation.

Wagner Steel-Frame Motors proved by years of service!

Wagner steel-frame drip-proof polyphase motors have been proved—durable, dependable, and trouble-free—by twenty years of hard usage in industry after industry.

These open-type squirrel-cage motors are available through 326 frame size, with either sleeve or ball bearings. The motor frames are formed of heavy rolled steel, shaped to accurately center the stator core and to provide passages for adequate ventilation. A large auxiliary fan draws in air through the openings in the front endplate, forces it through these passages and out through the endplate openings on the drive end. Heat is effectively carried off from all parts of the motor. Because of the fact that there are no openings in the frame, these motors are completely drip-proof when mounted in the normal horizontal position, and by rotating the endplates are still drip-proof in the sidewall or ceiling horizontal positions.

Bulletins give full information on the complete line of Wagner Motors. Thirty-one branches, located in principal cities, are ready to assist you whenever you have a motor problem. In addition, almost 500 authorized motor repair shops provide speedy, nationwide service facilities.

Wagner Electric Corporation
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AUTOMOTIVE BRAKE SYSTEMS — AIR AND HYDRAULIC

BRANCHES IN 31 PRINCIPAL CITIES

high ratios?

✳ ONE OF 93

DE LAVAL DOUBLE REDUCTION WORM GEARS

De Laval double reduction speed reducers, consisting of combinations of double worm gear reductions, or helical and worm gear reductions, are available with overall ratios up to approximately 8000 to 1. De Laval single reduction worm gear speed reducers are available in ratios up to 90 to 1. If high ratios are your requirement, worm gear speed reducers are the answer—particularly if space is limited and reliability is important. A De Laval representative will help you pick the right size and type.

✳ This double reduction De Laval Worm Gear Speed Reducer is available in many standard ratio combinations, with horizontal or vertical output shafts and is but one of 93 sizes of standard De Laval Worm Gear Speed Reducers.

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MODERATELY PRICED SMALL STEEL VALVES FROM THE COMPLETE CRANE LINE

UNION BONNET GATES . . . MORE COMPACT, MORE RUGGED

Here's a valve value made possible by Crane Co.'s finer facilities for *quality* mass production. These low-cost, small steel gates are specially designed for a wide range of tough services. They readily withstand rough usage, piping and pressure strains, and extreme variations in temperature. The features below show how and why they do it.

COMPACT OVERALL DESIGN—size for size, these valves are more compact than the usual high-pressure design—at no sacrifice of strength.

TIGHT UNION BONNET JOINT—heavy steel union ring with long, precision-cut threads pulls up easily, stays tight, protects against distortion when joint is opened. Male and female bonnet joint with soft iron gasket eliminates possibility of gasket blowout.

LEAKPROOF BODY SEAT RINGS—are securely rolled into the body. No danger of leakage around ring. Cannot loosen in service.

FULLY GUIDED SOLID WEDGE DISC—cannot get out of line or jam in body. Disc drag and wear on seating surfaces are minimized.

GET DESCRIPTIVE FOLDER AD-1741 for more data on these valves. Gives sizes, dimensions, and service recommendations. Ask your Crane Representative for a copy or write direct. These valves also listed in your Crane No. 49 Catalog, P. 223.

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EVERYTHING FOR EVERY PIPING SYSTEM

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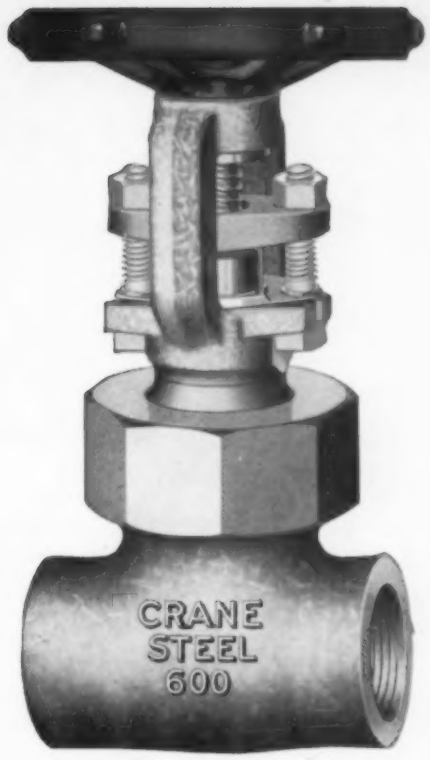
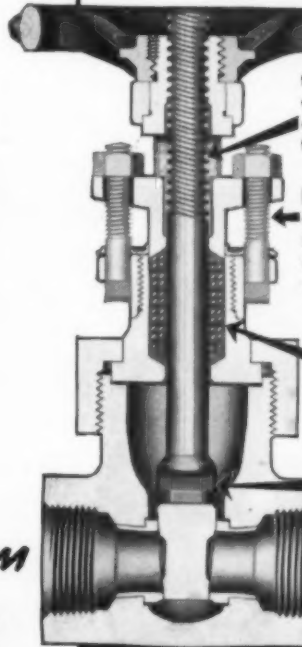


No. 3602XW, 600-Pound Small Steel Gate. for steam up to 850° F; for water, gas, air up to 500° F. Hardened stainless to Exelloy Seating. Sizes: ¼ to 2-inch. Screwed or welding ends.

Easy to operate . . . Easy to service



Outside screw and yoke. Stem threads are not exposed to erosive and corrosive effects of line fluids. Easy to lubricate.

Bolted packing gland can be pulled up easily. Bolts cannot come off in service; are easy to remove when necessary.

Extra deep stuffing box with one-piece gland and gland flange maintains tight stem seal.

T-head disc-stem connection prevents side strain on stem; gives flexibility for smooth operation.

Cross-section
No. 3602XW

DUCTILE IRON

is a very recent and revolutionary development in the casting industry

It has excellent founding properties .... can be readily cast into molds of intricate design, has better castability than steel, and can be cast in heavier sections than malleable. A few applications are listed at the right.

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- DIES ...
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- CYLINDERS ...
- PLUNGERS ...
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for:

PINCH ROLLS · COILER ROLLS
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No Scratching or Galling · More Tons Per Pass

THE YOUNGSTOWN FOUNDRY & MACHINE CO., YOUNGSTOWN, O.

OTHER PRODUCTS:

HYDRAULIC SLAB AND BILLET PILERS
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HOT BEDS—COOLING BEDS—TRANSFERS
BILLET EJECTORS—PINCH ROLL STANDS

SLITTERS—SPECIAL SHEARS AND GAUGES
TILTING TABLES—TRAVELING AND LIFTING TABLES
CONTINUOUS PICKLING LINES—ROLLER LEVELLERS
FURNACE CHARGING EQUIPMENT—FURNACE PUSHERS
STRIP STEEL COILERS AND REELS—SCRAP BALLERS

RAILROAD SPIKE FORMING MACHINES—ROLL LATHES
SHEET GALVANIZING LINES—WIRE PATENTING FRAMES
STRETCHER LEVELLERS—ANGLE AND SHAPE STRAIGHTENERS
ROLLING MILL TABLES—GEAR AND INDIVIDUAL MOTOR TYPES
MACHINERY BUILT TO CUSTOMER'S DESIGN AND DETAIL DRAWINGS

Publication Service...

JUNE, 1950

You Can Obtain...

... any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

(1) Cold Drawing Data Sheet

A product data sheet on a new, field-tested drawing compound for use in the cold drawing of hot or cold rolled bars or rods is announced. This product, known as Houghto-Draw 357, is a heavy paste containing high melting point waxes and fats combined with a colloidal pigment. It has high adhesive properties, and is applied by simple immersion of the work in a tank containing a solution of Houghto-Draw 357, 5 ounces to the gallon of water, maintained at 170 F. After draining and air drying, bars will be ready for drawing. E. F. Houghton & Co.

(2) Fire Brick

Just released is a new bulletin featuring Warco brand intermediate duty and high heat duty fire brick. Properties are detailed and general characteristics and uses are specified. Information on the facilities of the organization for the production of special fire clay shapes to meet practically every requirement is included, as well as data on other related products. Walsh Refractories Corp.

(3) Refractory Concrete

A revised edition of the booklet "Lumnite Refractory Concrete" has just been published. Latest available information on refractory and heat-resistant concrete is given in this new edition of the booklet. It is a manual of how-to-do-it information. Detailed information on refractory concrete mixes — proportions of Lumnite and various aggregates — is given in this booklet. From the tables contained in this publication, you can select the proper types of refractory concrete for a wide range of temperatures and insulating conditions. Lumnite division, Universal Atlas Cement Co.

(4) Fan Engineering Book

A new catalog is available giving full engineering information, dimensions, performance and prices regarding all types and sizes of fans for industrial, commercial and residential applications. This catalog includes many new types of fans with full details as to their application. Included is information on direct drive or belt driven window fans, industrial pressure fans, mancoolers, PH units, duct booster fans and various fans of all kinds and description. Also a full line of automatic counter balanced shutters for all applications. One of the most complete and easy to understand catalogs available on this subject. Chelsea Fan & Blower Co., Inc.

(5) "Wellman Will Build It" . . .

. . . is the title of a bulletin that is available to you. The booklet tells of the various types of equipment this company has built during the past 50 years. It describes blast furnace skip hoists, coal and ore bridges, buckets, transfer cars, quenching cars, dumpers, charging machines, coke oven machinery, furnaces and soaking pits, gas producers, valves, gas generators, and steel mill cranes and hoists. (144). Wellman Engineering Co.

(6) Heavy-Media Separators

Just issued is a completely new, 20-page catalog on the subject of wet classification and heavy-media separation devices. Comprehensive flow sheets and typical operating data are included. Principles of operation and construction details of the following equipment are discussed: counter-current classifier, counter-current heavy-media separator, heavy-media densifier, hydro-classifier, and hydro-separator. Hardinge Co., Inc.

(7) Fluid Flow Measurement

A new flow meter bulletin just released fully illustrates and explains flow measurement problems and their solution. Meter bodies, differential devices and reading instruments are fully described and a special section is included on wide range and reverse flow. The numerous illustrations in the book relate an informative pictorial story on fluid flow measurement. (702). Republic Flow Meters Co.

(8) Open Hearth Ladles

A folder is available describing welded open hearth ladles. This folder tells how in old plants where size of heats has been increased to capacities of cranes and buildings, a further increase of about 6 per cent in size of heats is possible with these welded ladles. Savings from increased size of heats often pay for new ladles in less than a year. William B. Pollock Co.

(9) Anti-Rust Service Report

How to combat rust throughout the production process in metalworking plants is the subject of a special service report just published. This service report offers a concise description of specialized materials and procedures that (1) remove rust from raw stock; (2) clean and derust in one operation; (3) prevent rust while parts are being processed; and (4) prepare metal for paint while affording protection against rust before and after painting. Also reported upon are materials, for use by machine or tank methods, that remove buffing compounds, drawing and stamping compounds, cutting and grinding lubricants, mill and slushing oils, solid-particle dirts and smuts from metal parts, and at the same time provide efficient temporary protection against rust. Oakite Products, Inc.

(10) Turbine Heater Bulletin

Publication of a new bulletin is announced on the Wing turbine driven unit heater. The unique feature of this heater is the elimination of electric motor for operating the fan, which is driven by a Wing steam turbine, the exhaust from the turbine being piped into the heater section for heating the air. Complete details of the design

and construction together with engineering data and dimensions both on the revolving discharge units and the fixed discharge units are included as well as a table on mounting heights and coverage. Piping details are also clearly shown.

(11) D-C Motors

A new bulletin covers d-c motors 250 to 6000 hp, high and low speed for direct, belt, or gear drive. Construction features are illustrated and discussed and a page is devoted to mechanical modifications, such as enclosed models and low-inertia mill type motors. (PB 8200). Elliott Co.

(12) D-C Generators

Announcement is made of a new publication that has just been released describing an expanded line of d-c generators. (B41-200). Electric Products Co.

(13) Differential Master Sender

A catalog is available describing a meter type differential master sender, a pneumatic machine used as the metering element in the measurement and control of steam, gas and liquid flow, liquid level, pressure differential and similar applications. The master sender is characterized by instantaneous response to all changes in applied differential and provides precise measurement over a continuous range from 50 in. water column to 150 psi at static pressures up to 2500 psi. (2150). Hagan Corp.

(14) Oil Seal Handbook

"Johns-Manville Clipper Seal," is a 16-page handbook of useful data for anyone needing information on oil seals. Photographs show where to use these oil seals and how to install them. Drawings illustrate how the lip and heel construction of these non-metallic oil seals can be varied. The text gives other pertinent information of importance to designers, engineers, and maintenance men. The booklet is divided into sections on the principle of these seals, their construction, advantages in various applications, installation data, and other information of interest to oil seal users. Johns-Manville.

(15) Pipe-Line Thermometer

Publication of a 6-page bulletin on pipe-line recording thermometers for natural and manufactured gas temperatures has just been announced by Bristol Co. In addition to a complete description of the "Series 500" pipe-line recording thermometer, considerable information is given on the specially-designed bulb. The bulletin is illustrated with photographs and drawings showing methods of application, as well as a typical chart record. (T-843). Bristol Co.

(16) Worm Gear Speed Reducers

A new speed reducer bulletin is available. The bulletin contains a complete description of standard "IMO-De Laval" horizontal worm gear speed reducers. It shows all available types and gives standard specifications. It also contains complete horsepower rating tables, overhung load ratings, dimension tables and information on how to select worm gears. (G-WB). De Laval Steam Turbine Co.

(17) Tool Steel Selector

The Crucible tool steel selector has been derived from a new method for the selection of tool steels designed on the fundamental basis that the application dictates the choice of the tool steel. The selector is not an "aid" or "guide" as is the case with other methods, but rather a "selector" in the true sense, which will prove an invaluable addition to the tool or die maker's tool box, the designer's instrument set, and the engineer's reference library. To use the selector, it is only necessary that the tool or die characteristics be known. By this is meant the type and condition of the material to be worked, the number of pieces to be produced, the method of working (i.e. — hot or cold) and the condition of the equipment to be used. About 98 per cent of all tool steel applications are covered by the six major classes shown on the blue outer ring of the selector. Crucible Steel Co. of America.

(18) Solderless Cable Connectors

A solderless cable connector descriptive sheet has just been issued. The sheet describes these connectors for lifting magnet service and for other heavy-duty circuits supplying motors, welders, etc. (906). Electric Controller and Manufacturing Co.

(19) Magnetic Starter

A catalog is available describing a new magnetic starter in sizes to 5 hp, 220 volts a-c, or 7½ hp, 440-550 volts a-c. The new starter is furnished with (1) dual voltage coils, (2) with or without built-in pilot controls, and (3) in general purpose or water-tight enclosure. The recently developed Furnas switchlet quickly attached to either side of the starter provides a means for adding extra circuits. (50). Furnas Electric Co.

(20) Phosphate Coating Chemicals Chart

A phosphate coating chemicals selection chart is available to you. The chart shows product and process, metal surfaces treated, type of coating, method of application, scale of production, typical products treated, chemicals required, pre-cleaning methods, phosphating bath conditions, acidulated rinse, object of coating, and many other details. American Chemical Paint Co.

(21) Care of Rotating Equipment

To promote intelligent and consistent maintenance of electrical machines, Allis-Chalmers is making available in booklet form a series of articles by Fraser Jeffrey, assistant to the company's chief electrical engineer, entitled "Care of Rotating Equipment." Contents of the 24-page booklet are broken down broadly into preventive maintenance and machine repairs. Under the former, such subjects as drying moist insulation, measuring insulation resistance, bearing clearances and proper machine applications are covered. Machine repair includes data on stator coil and slip ring rotor repairs and balancing of rotating equipment. The author holds that effective maintenance requires familiarity with an understanding of the structural and operating needs of a machine, knowing what to do, when to do it, and the establishment of a maintenance schedule rigidly adhered to. (05R7417). Allis-Chalmers Manufacturing Co.

(22) Industrial Crayon Guide

Doesn't it stand to reason that it requires a vastly different crayon to mark a piece of plate glass than one which is used on the outside of a boxcar, or to mark a hot steel ingot? The old fashioned idea that

a crayon is just something to make a mark with is long outdated. In the modern plant of today an industrial crayon is a highly specialized marking device — an industry tool that adds speed and efficiency to a job. To aid the user and handler of industrial crayons, a new guide has been published which clearly indicates the proper type of marker to select for any given purpose or surface. American Crayon Co.

(23) Stop and Check Valve

Cushioned triple acting non-return valves for steam control in case of damaged boilers or headers are described in a new bulletin just published. Available in sizes 2 in. to 30 in. for pressures from 125 to 1500 psi, these valves automatically isolate a damaged boiler against reverse steam flow as well as close down steaming boilers due to ruptured steam line or header beyond the valve. These valves automatically perform the following functions: (1) cut in boiler when boiler pressure equals header pressure. (2) close to isolate boiler when boiler pressure decreases below header pressure and (3) close to isolate boiler when header pressure decreases to approximately 8 lb below boiler pressure. Included in the bulletin are a complete technical description, engineering diagrams of the three different body and yoke patterns, a parts list and operation and installation instructions. (S1). Golden-AndersonValve Specialty Co.

(24) Useful Information for Foundrymen

One of the most popular booklets in the foundry industry, "Useful Information for Foundrymen," first printed by Whiting Corp., in 1946, has been recently revised and reprinted. Pocket-sized and bound in a heavy cardboard cover, the booklet contains over 42 pages of facts, figures, formulae, brick counts, fuel costs, etc., that Whiting has found answer the questions most frequently asked by foundrymen. This new printing is the fourth edition of "Useful Information for Foundrymen." So far, over 15,000 copies of the previous editions have been donated to foundrymen. The new edition is now ready for distribution.

(25) Insulation and Resistance Tester

A new booklet is available on the heavy-duty type of "Megger" insulation and resistance tester. The booklet gives a description of the tester, the various ratings, and the uses for these testers. The tester is a high-range, direct-reading ohmmeter for measuring electrical insulation resistance. The heavy-duty type of instrument, described in this bulletin, is mounted in a substantial teakwood case, together with a d-c generator arranged for either hand or motor operation. The instrument can be used for testing insulation resistance of practically all types and sizes of electrical equipment. Standardized ratings extend to as high as 50,000 megohms and 2500 volts d-c. A special 100,000 megohm, 5000 volts instrument is also available. (21-20). James G. Biddle Co.

(26) Car Unloader

A folder is available describing the Kinney car unloader. This booklet tells how to remove frozen coal out of hopper cars without the use of heat. (2-50). Heyl and Patterson, Inc.

(27) Electrical Construction

A folder is available describing the facilities of a company that specializes in electrical construction. This firm has been in business more than 30 years and has handled volumes of work in the millions of dollars per year for more than 15 years and single jobs of more than three millions of dollars. A few of their jobs have been overhead line construction, underground cable construction, and substations and power houses. Howard P. Foley Co.

(28) Ball Valve

A folder is available describing a ball valve that can be used for water, oil, gas, steam, chemicals and fuels. This is supposed to be the only valve on the market with interchangeable packings. These valves can be converted from one to another service in a few minutes. Carpenter Manufacturing Co.

(29) Air-Actuated Clutch

A complete file of literature is available to you on the Fawick "airflex" clutch. According to the literature, this clutch provides the solution to the ever present problem of an adequate clutch to match the improved construction available in other components of advanced design power transmission. Design improvements incorporated in the unit have eliminated the inefficiencies and undesirable features of old style clutches. The new clutch is actuated by air under pressure and is controlled by a finger pressure responsive valve. This air, carried through piping installed in the most suitable manner, obtains immediate clutch response. Levers, fulcrums, sliding collars, springs, and linkages are eliminated completely. Fawick Airflex Co., Inc.

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51	BAILEY METER CO.	BULLETIN 211	"Bailey Smoke Density Recorder," gives complete information on how to profitably use this unique instrument to erase your smoke troubles.
52	BEDFORD FOUNDRY AND MACHINE CO.		Catalog available on Bedford cranes.
53	BRANDT, INC., CHARLES T.	FILE NO. 509	Reference file is available describing complete manufacturing facilities.
54	BROWNING AND CO., INC., VICTOR R.	BULLETIN "S"	Describes Browning mill type cranes.
55	CITIES SERVICE OIL CO.		A catalog is available which gives complete details on combustion control for industry.
56	CLARK CONTROLLER CO.	BULLETINS 10620, 10630, 10640 and 10650	Gives complete details on the Clark fire pump motor controllers.
57	CLEVELAND WORM AND GEAR CO.	BULLETIN 125	Gives full description, capacity charts and dimension data on NU and ND worm gear units.
58	COLUMBIA ELECTRIC MANUFACTURING CO.	CATALOG IS-700	Gives complete details on motor generators.
59	CRANE CO.	FOLDER AD-1741	Gives sizes, dimensions and service recommendations on the Crane line of valves.
60	CROCKER-WHEELER DIVISION, ELLIOTT CO.	BULLETIN SL-620-1	Bulletin describes Crocker-Wheeler auxiliary mill motors.
61	CUNNINGHAM CO., M. E.	BULLETIN LF-50	Describes safety in marking all kinds of metal.
62	DE LAVAL STEAM TURBINE CO.	CATALOG GWB-14-R	Gives full details on De Laval double reduction worm gears.
63	DURABLA MANUFACTURING CO.	BULLETIN NO. O S 6	Complete information available on Durabla pump valve units.
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INDEX TO ADVERTISERS

A

Aetna-Standard Engineering Co. 1
Alliance Machine Co. 5
Askania Regulator Co. 34

B

Bailey Meter Co. 155
Bantam Bearings Division of The Torrington Co. 159
Bedford Foundry and Machine Co. 148
Birdsboro Steel Foundry and Machine Co. 40
Bliss Co., E. W. 42
Bloom Engineering Co. 148
Bonnot Co. 4
Bowser, Inc. 152
Brandt, Inc., Charles T. 161
Browning Co., Inc., Victor R. 152
Buffalo Forge Co. 48

C

Cities Service Oil Co. 41
Clark Controller Co. 25
Cleveland Crane and Engineering Co. 46
Cleveland Worm and Gear Co., The Cover 3
Columbia Electric Manufacturing Co. 149
Continental Foundry and Machine Co. 12, 13
Crane Co. 167
Crocker-Wheeler Electric Manufacturing Co., Division Elliott Co. 37
Crucible Steel Co. of America 10
Cunningham Co., M. E. 149
Cutler-Hammer, Inc. Cover 2

D

De Laval Separator Co. 30
De Laval Steam Turbine Co. 166
Documentation & Licenses, Paris, France 50
Dowell, Inc. 126
Dravo Corp. 153
Drever Co., The 50
Durabla Manufacturing Co. 176

E

Eichleay Corp. 125
Electric Controller and Manufacturing Co. 8, 134
Electric Service Manufacturing Co. 142
Electric Storage Battery Co. 14

F

Falcon Bronze Co. 153
Farrel-Birmingham Co., Inc. 20
Fawick Airflex Co. 137
Flinn & Dreffein Engineering Co. 50
Furnace Engineers, Inc. 133

G

General Electric Co. Cover 4

H

Hagan Corp. 9
Hallden Machine Co., The 50
Harnischfeger Corp. 39
Heppenstall Co. 129
Homestead Valve Manufacturing Co., Inc. 16
Hyde Park Foundry and Machine Co. 154

I

Iron and Steel Exposition 31

J

Jones Foundry and Machine Co., W. A. 141

K

Koppers Co., Inc. 150, 151

L

Leeds and Northrup Co. 49
Leslie Co. 140
Lewis Foundry and Machine Division, Blaw-Knox Co. 19
Linde Air Products Co., The Unit of Union Carbide and Carbon Corp. 15
Link-Belt Co. 162
Lintern Corp. 147

M

Mackintosh-Hemphill Co. 35
Magor Car Corp. 6
Manning, Maxwell and Moore, Inc., Shaw-Box Crane and Hoist Division 22
Mathews Conveyer Co. 135
Medart Co., The 136
Mesta Machine Co. Cover 1
John Miles & Partner (London, Ltd.) 50
Minneapolis-Honeywell Regulator Co. (Industrial Division) 124
Morgan Construction Co. 23
Morgan Engineering Co. 156

N

National Carbon Division, Union Carbide and Carbon Corp. 144
National Roll & Foundry Co. 2

O

Oakite Products, Inc. 140
Ohio Electric Manufacturing Co. 130
Okonite Co., The 44

P

Pennsylvania Engineering Corp. 163
Pennsylvania Transformer Co. 32
Pittsburgh Lectromelt Furnace Corp. 52
Poole Foundry and Machine Co. 18
Post-Glover Electric Co. 36

R

Rust Furnace Co. 123
Rust-Oleum Corp. 11

S

Salem Engineering Co. 21
Shell Oil Co. 7
Smeeth-Harwood Co. 154
Stearns Magnetic Manufacturing Co. 132
Surface Combustion Corp. 28, 29

T

Taylor Sons Co., Chas. 38
Taylor Chain Co., S. G. 138
Texas Co., The 3
Tide Water Associated Oil Co. 24
Timken Roller Bearing Co. 43
Torrington Manufacturing Co., The 139

U

Union Carbide and Carbon Corp., The Linde Air Products Co., Unit 15
Union Carbide and Carbon Corp., National Carbon Division 144
Union Steel Castings Division, Blaw-Knox Co. 33
United Engineering and Foundry Co. 17

W

Wagner Electric Corp. 165
Ware Fuse Corp. 154
Wean Engineering Co., Inc., The 50
Wean Engineering Co. of Canada, Limited, The 50
Wean Equipment Corp. 50
Westinghouse Electric Corp. 26, 27
Whitcomb Locomotive Co., The 143
Wilson Engineering Co., Inc., Lee 45

Y

Youngstown Alloy Casting Corp. 164
Youngstown Foundry and Machine Co. 168

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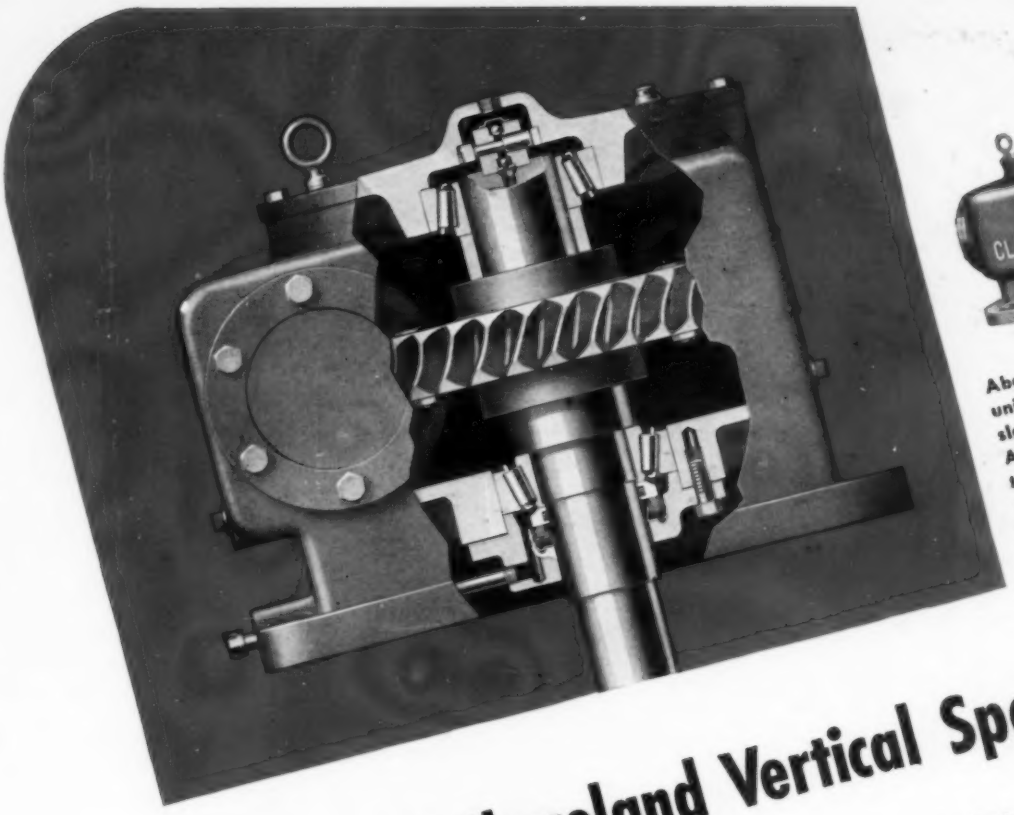

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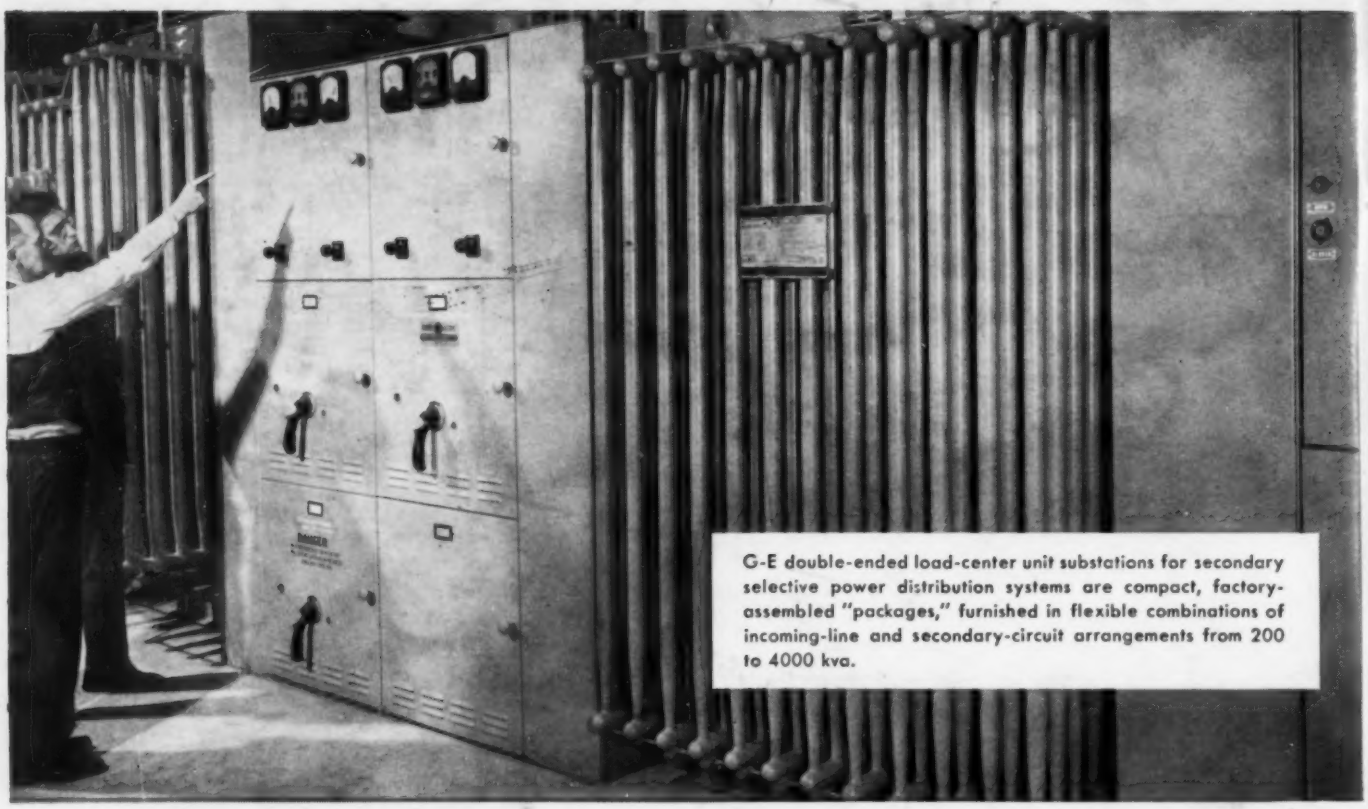
Heavy base flange extends around all four sides. All parts liberally oversized and precision built.

Write for Bulletin 125 for full description of Types NU and ND, including capacity charts and dimension data. The Cleveland Worm & Gear Co., 3278 East 80th Street, Cleveland 4, Ohio.

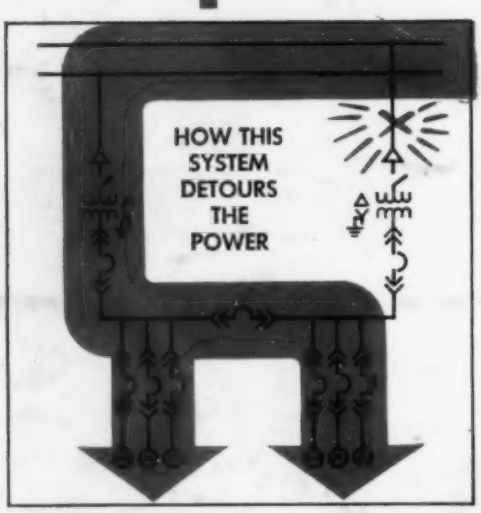
Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers, Limited.

CLEVELAND
Worm Gear
Speed Reducers



G-E double-ended load-center unit substations for secondary selective power distribution systems are compact, factory-assembled "packages," furnished in flexible combinations of incoming-line and secondary-circuit arrangements from 200 to 4000 kva.

G-E Unit Substations keep steel-making "on the go!"



As this simplified diagram shows, an alternate power source for secondary circuits is provided by closing the tie circuit breaker between the secondaries of two transformers. Thus, if a primary-circuit fault de-energizes one transformer, essential load is detoured to the other, and important production keeps going.

Secondary selective feature provides alternate route for power—protects service continuity

Here's a low-cost way to safeguard service continuity in steel mills: distribute your plant power through a secondary selective power system using General Electric double-ended or pairs of single-ended unit substations. By providing two separate power sources for every secondary, this method in effect permits detouring essential loads from one transformer, temporarily out of service, to its working partner.

Simplicity and safety are other advantages of this system. No special training is needed to operate and maintain the equipment contained in a G-E load-center unit substation. All units are completely metal-enclosed to protect operating personnel.

Moreover, expansion is easy and economical. Single-ended or double-ended unit substations can be added at will. Since no added interrupting duty is imposed, no new secondary switchgear is needed on existing units. Full data is contained in Bulletin GEA-3758. Send today for your copy. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

For helpful, cost-cutting ideas, see "Modern Industrial Power Distribution," a More Power to America slidefilm in full color and sound. Your G-E representative will gladly arrange a showing.

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